

PYRAZOLE COMPOUNDS USEFUL AS PROTEIN KINASE INHIBITORSCROSS REFERENCE TO RELATED APPLICATIONS

This application claims priority to US Provisional Patent Application 60/257,887 filed December 21, 2000 and US Provisional Patent Application 60/286,949 filed April 27, 2001, the contents of which are incorporated herein by reference.

FIELD OF THE INVENTION

The present invention is in the field of medicinal chemistry and relates to compounds that are protein kinase inhibitors, compositions containing such compounds and methods of use. More particularly, this invention relates to compounds that are inhibitors of Aurora-2 protein kinase. The invention also relates to methods of treating diseases associated with protein kinases, especially diseases associated with Aurora-2, such as cancer.

10

BACKGROUND OF THE INVENTION

The search for new therapeutic agents has been greatly aided in recent years by better understanding of the structure of enzymes and other biomolecules associated with target diseases. One important class of enzymes that has been the subject of extensive study is the protein kinases.

15

Protein kinases mediate intracellular signal transduction. They do this by effecting a phosphoryl transfer from a nucleoside triphosphate to a protein acceptor that is involved in a signaling pathway. There are a number of kinases and pathways through which

20

extracellular and other stimuli cause a variety of cellular responses to occur inside the cell. Examples of such stimuli include environmental and chemical stress signals (e.g. osmotic shock, heat shock, ultraviolet
5 radiation, bacterial endotoxin, H_2O_2), cytokines (e.g. interleukin-1 (IL-1) and tumor necrosis factor α (TNF- α)), and growth factors (e.g. granulocyte macrophage-colony-stimulating factor (GM-CSF), and fibroblast growth factor (FGF)). An extracellular stimulus may effect one
10 or more cellular responses related to cell growth, migration, differentiation, secretion of hormones, activation of transcription factors, muscle contraction, glucose metabolism, control of protein synthesis and regulation of cell cycle.

15 Many diseases are associated with abnormal cellular responses triggered by protein kinase-mediated events. These diseases include autoimmune diseases, inflammatory diseases, neurological and neurodegenerative diseases, cancer, cardiovascular diseases, allergies and
20 asthma, Alzheimer's disease or hormone-related diseases. Accordingly, there has been a substantial effort in medicinal chemistry to find protein kinase inhibitors that are effective as therapeutic agents.

Aurora-2 is a serine/threonine protein kinase
25 that has been implicated in human cancer, such as colon, breast and other solid tumors. This kinase is believed to be involved in protein phosphorylation events that regulate the cell cycle. Specifically, Aurora-2 may play a role in controlling the accurate segregation of
30 chromosomes during mitosis. Misregulation of the cell cycle can lead to cellular proliferation and other abnormalities. In human colon cancer tissue, the aurora-2 protein has been found to be overexpressed. See

Bischoff et al., *EMBO J.*, 1998, 17, 3052-3065; Schumacher et al., *J. Cell Biol.*, 1998, 143, 1635-1646; Kimura et al., *J. Biol. Chem.*, 1997, 272, 13766-13771.

Glycogen synthase kinase-3 (GSK-3) is a
5 serine/threonine protein kinase comprised of α and β
isoforms that are each encoded by distinct genes [Coghlan
et al., *Chemistry & Biology*, 7, 793-803 (2000); Kim and
Kimmel, *Curr. Opinion Genetics Dev.*, 10, 508-514 (2000)].
GSK-3 has been implicated in various diseases including
10 diabetes, Alzheimer's disease, CNS disorders such as
manic depressive disorder and neurodegenerative diseases,
and cardiomyocyte hypertrophy [WO 99/65897; WO 00/38675;
and Haq et al., *J. Cell Biol.* (2000) 151, 117]. These
diseases may be caused by, or result in, the abnormal
15 operation of certain cell signaling pathways in which
GSK-3 plays a role. GSK-3 has been found to
phosphorylate and modulate the activity of a number of
regulatory proteins. These proteins include glycogen
synthase which is the rate limiting enzyme necessary for
20 glycogen synthesis, the microtubule associated protein
Tau, the gene transcription factor β -catenin, the
translation initiation factor eIF2B, as well as ATP
citrate lyase, axin, heat shock factor-1, c-Jun, c-Myc,
c-Myb, CREB, and CEPB α . These diverse protein targets
25 implicate GSK-3 in many aspects of cellular metabolism,
proliferation, differentiation and development.

In a GSK-3 mediated pathway that is relevant
for the treatment of type II diabetes, insulin-induced
signaling leads to cellular glucose uptake and glycogen
30 synthesis. Along this pathway, GSK-3 is a negative
regulator of the insulin-induced signal. Normally, the
presence of insulin causes inhibition of GSK-3 mediated

phosphorylation and deactivation of glycogen synthase. The inhibition of GSK-3 leads to increased glycogen synthesis and glucose uptake [Klein et al., *PNAS*, 93, 8455-9 (1996); Cross et al., *Biochem. J.*, 303, 21-26
5 (1994); Cohen, *Biochem. Soc. Trans.*, 21, 555-567 (1993); Massillon et al., *Biochem J.* 299, 123-128 (1994)]. However, in a diabetic patient where the insulin response is impaired, glycogen synthesis and glucose uptake fail to increase despite the presence of relatively high blood
10 levels of insulin. This leads to abnormally high blood levels of glucose with acute and long term effects that may ultimately result in cardiovascular disease, renal failure and blindness. In such patients, the normal insulin-induced inhibition of GSK-3 fails to occur. It
15 has also been reported that in patients with type II diabetes, GSK-3 is overexpressed [WO 00/38675]. Therapeutic inhibitors of GSK-3 are therefore potentially useful for treating diabetic patients suffering from an impaired response to insulin.

20 GSK-3 activity has also been associated with Alzheimer's disease. This disease is characterized by the well-known β -amyloid peptide and the formation of intracellular neurofibrillary tangles. The neurofibrillary tangles contain hyperphosphorylated Tau
25 protein where Tau is phosphorylated on abnormal sites. GSK-3 has been shown to phosphorylate these abnormal sites in cell and animal models. Furthermore, inhibition of GSK-3 has been shown to prevent hyperphosphorylation of Tau in cells [Lovestone et al., *Current Biology* 4,
30 1077-86 (1994); Brownlee et al., *Neuroreport* 8, 3251-55 (1997)]. Therefore, it is believed that GSK-3 activity may promote generation of the neurofibrillary tangles and the progression of Alzheimer's disease.

Another substrate of GSK-3 is β -catenin which is degraded after phosphorylation by GSK-3. Reduced levels of β -catenin have been reported in schizophrenic patients and have also been associated with other
5 diseases related to increase in neuronal cell death [Zhong et al., *Nature*, 395, 698-702 (1998); Takashima et al., *PNAS*, 90, 7789-93 (1993); Pei et al., *J. Neuropathol. Exp*, 56, 70-78 (1997)].

As a result of the biological importance of
10 GSK-3, there is current interest in therapeutically effective GSK-3 inhibitors. Small molecules that inhibit GSK-3 have recently been reported [WO 99/65897 (Chiron) and WO 00/38675 (SmithKline Beecham)].

For many of the aforementioned diseases
15 associated with abnormal GSK-3 activity, other protein kinases have also been targeted for treating the same diseases. However, the various protein kinases often act through different biological pathways. For example, certain quinazoline derivatives have been reported
20 recently as inhibitors of p38 kinase (WO 00/12497 to Scios). The compounds are reported to be useful for treating conditions characterized by enhanced p38- α activity and/or enhanced TGF- β activity. While p38 activity has been implicated in a wide variety of
25 diseases, including diabetes, p38 kinase is not reported to be a constituent of an insulin signaling pathway that regulates glycogen synthesis or glucose uptake. Therefore, unlike GSK-3, p38 inhibition would not be
30 uptake.

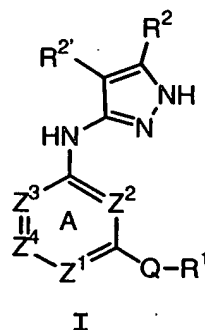
There is a continued need to find new therapeutic agents to treat human diseases. The protein

kinases Aurora-2 and GSK-3 are especially attractive targets for the discovery of new therapeutics due to their important roles in cancer and diabetes, respectively.

5

DESCRIPTION OF THE INVENTION

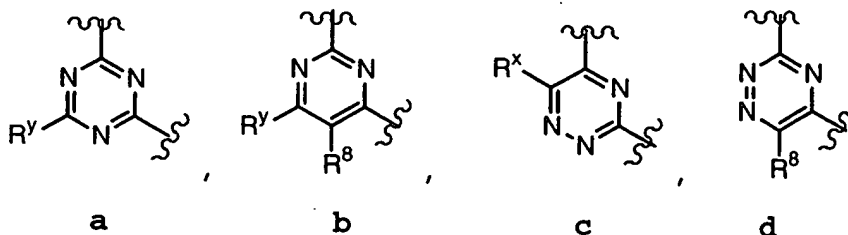
It has now been found that compounds of this invention and pharmaceutical compositions thereof are effective as protein kinase inhibitors, particularly as inhibitors of Aurora-2. These compounds have the general formula I:

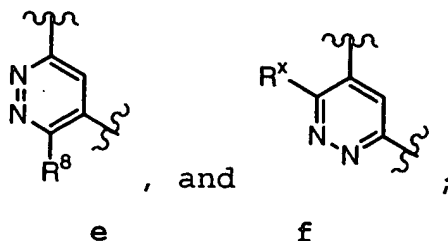


or a pharmaceutically acceptable derivative or prodrug thereof, wherein:

Z¹ to Z⁴ are as described below;

15 Ring A is selected from the group consisting of:





- R^x is $T-R^3$ or $L-Z-R^3$;
- R^y is $Z-R^3$ or an optionally substituted group selected from C_{1-6} aliphatic, C_{6-10} aryl, a heteroaryl ring having 5-10 ring atoms, or a heterocyclyl ring having 5-10 ring atoms, or R^y and R^8 are taken together to form a fused, optionally substituted 5-7 membered, unsaturated or partially unsaturated, ring having 0-3 ring heteroatoms selected from nitrogen, oxygen, or sulfur;
- Q is selected from $-N(R^4)-$, $-O-$, $-S-$, or $-CH(R^6)-$;
- 10 R^1 is $T-(\text{Ring D})$;
- Ring D is a 5-7 membered monocyclic ring or 8-10 membered bicyclic ring selected from aryl, heteroaryl, heterocyclyl or carbocyclyl, said heteroaryl or heterocyclyl ring having 1-4 ring heteroatoms selected from nitrogen, oxygen or sulfur, wherein each
- 15 substitutable ring carbon of Ring D is independently substituted by oxo, $T-R^5$, or $V-Z-R^5$, and each substitutable ring nitrogen of Ring D is independently substituted by $-R^4$;
- 20 T is a valence bond or a C_{1-4} alkylidene chain, wherein when Q is $-CH(R^6)-$, a methylene unit of said C_{1-4} alkylidene chain is optionally replaced by $-O-$, $-S-$, $-N(R^4)-$, $-CO-$, $-CONH-$, $-NHCO-$, $-SO_2-$, $-SO_2NH-$, $-NHSO_2-$, $-CO_2-$, $-OC(O)-$, $-OC(O)NH-$, or $-NHCO_2-$;
- 25 Z is a C_{1-4} alkylidene chain;
- L is $-O-$, $-S-$, $-SO-$, $-SO_2-$, $-N(R^6)SO_2-$, $-SO_2N(R^6)-$, $-N(R^6)-$, $-CO-$, $-CO_2-$, $-N(R^6)CO-$, $-N(R^6)C(O)O-$,

-N(R⁶)CON(R⁶)-, -N(R⁶)SO₂N(R⁶)-, -N(R⁶)N(R⁶)-,
 -C(O)N(R⁶)-, -OC(O)N(R⁶)-, -C(R⁶)₂O-, -C(R⁶)₂S-,
 -C(R⁶)₂SO-, -C(R⁶)₂SO₂-, -C(R⁶)₂SO₂N(R⁶)-, -C(R⁶)₂N(R⁶)-,
 -C(R⁶)₂N(R⁶)C(O)-, -C(R⁶)₂N(R⁶)C(O)O-, -C(R⁶)=NN(R⁶)-,
 5 -C(R⁶)=N-O-, -C(R⁶)₂N(R⁶)N(R⁶)-, -C(R⁶)₂N(R⁶)SO₂N(R⁶)-, or
 -C(R⁶)₂N(R⁶)CON(R⁶)-;

R² and R^{2'} are independently selected from -R, -T-W-R⁶, or
 R² and R^{2'} are taken together with their intervening
 atoms to form a fused, 5-8 membered, unsaturated or
 10 partially unsaturated, ring having 0-3 ring heteroatoms
 selected from nitrogen, oxygen, or sulfur, wherein each
 substitutable ring carbon of said fused ring formed by
 R² and R^{2'} is independently substituted by halo, oxo,
 -CN, -NO₂, -R⁷, or -V-R⁶, and each substitutable ring
 15 nitrogen of said ring formed by R² and R^{2'} is
 independently substituted by R⁴;

R³ is selected from -R, -halo, -OR, -C(=O)R, -CO₂R,
 -COCOR, -COCH₂COR, -NO₂, -CN, -S(O)R, -S(O)₂R, -SR,
 -N(R⁴)₂, -CON(R⁷)₂, -SO₂N(R⁷)₂, -OC(=O)R, -N(R⁷)COR,
 20 -N(R⁷)CO₂(C₁₋₆ aliphatic), -N(R⁴)N(R⁴)₂, -C=NN(R⁴)₂,
 -C=N-OR, -N(R⁷)CON(R⁷)₂, -N(R⁷)SO₂N(R⁷)₂, -N(R⁴)SO₂R, or
 -OC(=O)N(R⁷)₂;

R^{3'} is selected from -halo, -OR, -C(=O)R, -CO₂R, -COCOR,
 -COCH₂COR, -NO₂, -CN, -S(O)R, -S(O)₂R, -SR, -N(R⁴)₂,
 25 -CON(R⁷)₂, -SO₂N(R⁷)₂, -OC(=O)R, -N(R⁷)COR, -N(R⁷)CO₂(C₁₋₆
 aliphatic), -N(R⁴)N(R⁴)₂, -C=NN(R⁴)₂, -C=N-OR,
 -N(R⁷)CON(R⁷)₂, -N(R⁷)SO₂N(R⁷)₂, -N(R⁴)SO₂R,
 -OC(=O)N(R⁷)₂, or an optionally substituted group
 selected from C₁₋₆ aliphatic, C₆₋₁₀ aryl, a heteroaryl
 30 ring having 5-10 ring atoms, or a heterocyclyl ring
 having 5-10 ring atoms;

each R is independently selected from hydrogen or an
 optionally substituted group selected from C₁₋₆

aliphatic, C₆₋₁₀ aryl, a heteroaryl ring having 5-10 ring atoms, or a heterocyclyl ring having 5-10 ring atoms;

each R⁴ is independently selected from -R⁷, -COR⁷,
 5 -CO₂(optionally substituted C₁₋₆ aliphatic), -CON(R⁷)₂,
 or -SO₂R⁷;

each R⁵ is independently selected from -R, halo, -OR,
 -C(=O)R, -CO₂R, -COCOR, -NO₂, -CN, -S(O)R, -SO₂R, -SR,
 -N(R⁴)₂, -CON(R⁴)₂, -SO₂N(R⁴)₂, -OC(=O)R, -N(R⁴)COR,
 10 -N(R⁴)CO₂(optionally substituted C₁₋₆ aliphatic),
 -N(R⁴)N(R⁴)₂, -C=NN(R⁴)₂, -C=N-OR, -N(R⁴)CON(R⁴)₂,
 -N(R⁴)SO₂N(R⁴)₂, -N(R⁴)SO₂R, or -OC(=O)N(R⁴)₂;

V is -O-, -S-, -SO-, -SO₂-, -N(R⁶)SO₂-, -SO₂N(R⁶)-,
 -N(R⁶)-, -CO-, -CO₂-, -N(R⁶)CO-, -N(R⁶)C(O)O-,
 15 -N(R⁶)CON(R⁶)-, -N(R⁶)SO₂N(R⁶)-, -N(R⁶)N(R⁶)-,
 -C(O)N(R⁶)-, -OC(O)N(R⁶)-, -C(R⁶)₂O-, -C(R⁶)₂S-,
 -C(R⁶)₂SO-, -C(R⁶)₂SO₂-, -C(R⁶)₂SO₂N(R⁶)-, -C(R⁶)₂N(R⁶)-,
 -C(R⁶)₂N(R⁶)C(O)-, -C(R⁶)₂N(R⁶)C(O)O-, -C(R⁶)=NN(R⁶)-,
 -C(R⁶)=N-O-, -C(R⁶)₂N(R⁶)N(R⁶)-, -C(R⁶)₂N(R⁶)SO₂N(R⁶)-, or
 20 -C(R⁶)₂N(R⁶)CON(R⁶)-;

W is -C(R⁶)₂O-, -C(R⁶)₂S-, -C(R⁶)₂SO-, -C(R⁶)₂SO₂-,
 -C(R⁶)₂SO₂N(R⁶)-, -C(R⁶)₂N(R⁶)-, -CO-, -CO₂-,
 -C(R⁶)OC(O)-, -C(R⁶)OC(O)N(R⁶)-, -C(R⁶)₂N(R⁶)CO-,
 -C(R⁶)₂N(R⁶)C(O)O-, -C(R⁶)=NN(R⁶)-, -C(R⁶)=N-O-,
 25 -C(R⁶)₂N(R⁶)N(R⁶)-, -C(R⁶)₂N(R⁶)SO₂N(R⁶)-,
 -C(R⁶)₂N(R⁶)CON(R⁶)-, or -CON(R⁶)-;

each R⁶ is independently selected from hydrogen or an
 optionally substituted C₁₋₄ aliphatic group, or two R⁶
 groups on the same nitrogen atom are taken together
 30 with the nitrogen atom to form a 5-6 membered
 heterocyclyl or heteroaryl ring;

each R⁷ is independently selected from hydrogen or an
 optionally substituted C₁₋₆ aliphatic group, or two R⁷

on the same nitrogen are taken together with the nitrogen to form a 5-8 membered heterocyclyl or heteroaryl ring; and

5 R^8 is selected from -R, halo, -OR, -C(=O)R, -CO₂R, -COCOR, -NO₂, -CN, -S(O)R, -SO₂R, -SR, -N(R⁴)₂, -CON(R⁴)₂, -SO₂N(R⁴)₂, -OC(=O)R, -N(R⁴)COR, -N(R⁴)CO₂(optionally substituted C₁₋₆ aliphatic), -N(R⁴)N(R⁴)₂, -C=NN(R⁴)₂, -C=N-OR, -N(R⁴)CON(R⁴)₂, -N(R⁴)SO₂N(R⁴)₂, -N(R⁴)SO₂R, or -OC(=O)N(R⁴)₂.

10 As used herein, the following definitions shall apply unless otherwise indicated. The phrase "optionally substituted" is used interchangeably with the phrase "substituted or unsubstituted" or with the term "(un)substituted." Unless otherwise indicated, an
15 optionally substituted group may have a substituent at each substitutable position of the group, and each substitution is independent of the other.

The term "aliphatic" as used herein means straight-chain, branched or cyclic C₁-C₁₂ hydrocarbons
20 which are completely saturated or which contain one or more units of unsaturation but which are not aromatic. For example, suitable aliphatic groups include substituted or unsubstituted linear, branched or cyclic alkyl, alkenyl, alkynyl groups and hybrids thereof such
25 as (cycloalkyl)alkyl, (cycloalkenyl)alkyl or (cycloalkyl)alkenyl. The terms "alkyl", "alkoxy", "hydroxyalkyl", "alkoxyalkyl", and "alkoxycarbonyl", used alone or as part of a larger moiety includes both straight and branched chains containing one to twelve
30 carbon atoms. The terms "alkenyl" and "alkynyl" used alone or as part of a larger moiety shall include both straight and branched chains containing two to twelve carbon atoms. The term "cycloalkyl" used alone or as

part of a larger moiety shall include cyclic C₃-C₁₂ hydrocarbons which are completely saturated or which contain one or more units of unsaturation, but which are not aromatic.

5 The terms "haloalkyl", "haloalkenyl" and "haloalkoxy" means alkyl, alkenyl or alkoxy, as the case may be, substituted with one or more halogen atoms. The term "halogen" means F, Cl, Br, or I.

10 The term "heteroatom" means nitrogen, oxygen, or sulfur and includes any oxidized form of nitrogen and sulfur, and the quaternized form of any basic nitrogen. Also the term "nitrogen" includes a substitutable nitrogen of a heterocyclic ring. As an example, in a saturated or partially unsaturated ring having 0-3
15 heteroatoms selected from oxygen, sulfur or nitrogen, the nitrogen may be N (as in 3,4-dihydro-2H-pyrrolyl), NH (as in pyrrolidinyl) or NR⁺ (as in N-substituted pyrrolidinyl).

 The terms "carbocycle", "carbocyclyl",
20 "carbocyclo", or "carbocyclic" as used herein means an aliphatic ring system having three to fourteen members. The terms "carbocycle", "carbocyclyl", "carbocyclo", or "carbocyclic" whether saturated or partially unsaturated, also refers to rings that are optionally substituted.
25 The terms "carbocycle", "carbocyclyl", "carbocyclo", or "carbocyclic" also include aliphatic rings that are fused to one or more aromatic or nonaromatic rings, such as in a decahydronaphthyl or tetrahydronaphthyl, where the radical or point of attachment is on the aliphatic ring.

30 The term "aryl" used alone or as part of a larger moiety as in "aralkyl", "aralkoxy", or "aryloxyalkyl", refers to aromatic ring groups having five to fourteen members, such as phenyl, benzyl,

phenethyl, 1-naphthyl, 2-naphthyl, 1-anthracyl and 2-anthracyl. The term "aryl" also refers to rings that are optionally substituted. The term "aryl" may be used interchangeably with the term "aryl ring". "Aryl" also
5 includes fused polycyclic aromatic ring systems in which an aromatic ring is fused to one or more rings. Examples include 1-naphthyl, 2-naphthyl, 1-anthracyl and 2-anthracyl. Also included within the scope of the term "aryl", as it is used herein, is a group in which an
10 aromatic ring is fused to one or more non-aromatic rings, such as in an indanyl, phenanthridinyl, or tetrahydronaphthyl, where the radical or point of attachment is on the aromatic ring.

The term "heterocycle", "heterocyclyl", or
15 "heterocyclic" as used herein includes non-aromatic ring systems having five to fourteen members, preferably five to ten, in which one or more ring carbons, preferably one to four, are each replaced by a heteroatom such as N, O, or S. Examples of heterocyclic rings include 3-1H-
20 benzimidazol-2-one, (1-substituted)-2-oxo-benzimidazol-3-yl, 2-tetrahydrofuranyl, 3-tetrahydrofuranyl, 2-tetrahydropyranyl, 3-tetrahydropyranyl, 4-tetrahydropyranyl, [1,3]-dioxalanyl, [1,3]-dithiolanyl, [1,3]-dioxanyl, 2-tetrahydrothiophenyl, 3-
25 tetrahydrothiophenyl, 2-morpholinyl, 3-morpholinyl, 4-morpholinyl, 2-thiomorpholinyl, 3-thiomorpholinyl, 4-thiomorpholinyl, 1-pyrrolidinyl, 2-pyrrolidinyl, 3-pyrrolidinyl, 1-piperazinyl, 2-piperazinyl, 1-piperidinyl, 2-piperidinyl, 3-piperidinyl, 4-piperidinyl,
30 4-thiazolidinyl, diazolonyl, N-substituted diazolonyl, 1-phthalimidinyl, benzoxanyl, benzopyrrolidinyl, benzopiperidinyl, benzoxolanyl, benzothiolanyl, and benzothianyl. Also included within the scope of the term

"heterocyclyl" or "heterocyclic", as it is used herein, is a group in which a non-aromatic heteroatom-containing ring is fused to one or more aromatic or non-aromatic rings, such as in an indolinyl, chromanyl, phenanthridinyl, or tetrahydroquinolinyl, where the radical or point of attachment is on the non-aromatic heteroatom-containing ring. The term "heterocycle", "heterocyclyl", or "heterocyclic" whether saturated or partially unsaturated, also refers to rings that are optionally substituted.

The term "heteroaryl", used alone or as part of a larger moiety as in "heteroaralkyl" or "heteroarylalkoxy", refers to heteroaromatic ring groups having five to fourteen members. Examples of heteroaryl rings include 2-furanyl, 3-furanyl, N-imidazolyl, 2-imidazolyl, 4-imidazolyl, 5-imidazolyl, 3-isoxazolyl, 4-isoxazolyl, 5-isoxazolyl, 2-oxadiazolyl, 5-oxadiazolyl, 2-oxazolyl, 4-oxazolyl, 5-oxazolyl, 1-pyrrolyl, 2-pyrrolyl, 3-pyrrolyl, 2-pyridyl, 3-pyridyl, 4-pyridyl, 2-pyrimidyl, 4-pyrimidyl, 5-pyrimidyl, 3-pyridazinyl, 2-thiazolyl, 4-thiazolyl, 5-thiazolyl, 5-tetrazolyl, 2-triazolyl, 5-triazolyl, 2-thienyl, 3-thienyl, carbazolyl, benzimidazolyl, benzothienyl, benzofuranyl, indolyl, quinolinyl, benzotriazolyl, benzothiazolyl, benzooxazolyl, benzimidazolyl, isoquinolinyl, indazolyl, isoindolyl, acridinyl, or benzoisoxazolyl. Also included within the scope of the term "heteroaryl", as it is used herein, is a group in which a heteroatomic ring is fused to one or more aromatic or nonaromatic rings where the radical or point of attachment is on the heteroaromatic ring. Examples include tetrahydroquinolinyl, tetrahydroisoquinolinyl, and pyrido[3,4-d]pyrimidinyl. The term "heteroaryl" also refers to rings that are

optionally substituted. The term "heteroaryl" may be used interchangeably with the term "heteroaryl ring" or the term "heteroaromatic".

An aryl (including aralkyl, aralkoxy, aryloxyalkyl and the like) or heteroaryl (including heteroaralkyl and heteroarylalkoxy and the like) group may contain one or more substituents. Examples of suitable substituents on the unsaturated carbon atom of an aryl, heteroaryl, aralkyl, or heteroaralkyl group include a halogen, $-R^\circ$, $-OR^\circ$, $-SR^\circ$, 1,2-methylene-dioxy, 1,2-ethylenedioxy, protected OH (such as acyloxy), phenyl (Ph), substituted Ph, $-O(Ph)$, substituted $-O(Ph)$, $-CH_2(Ph)$, substituted $-CH_2(Ph)$, $-CH_2CH_2(Ph)$, substituted $-CH_2CH_2(Ph)$, $-NO_2$, $-CN$, $-N(R^\circ)_2$, $-NR^\circ C(O)R^\circ$, $-NR^\circ C(O)N(R^\circ)_2$, $-NR^\circ CO_2R^\circ$, $-NR^\circ NR^\circ C(O)R^\circ$, $-NR^\circ NR^\circ C(O)N(R^\circ)_2$, $-NR^\circ NR^\circ CO_2R^\circ$, $-C(O)C(O)R^\circ$, $-C(O)CH_2C(O)R^\circ$, $-CO_2R^\circ$, $-C(O)R^\circ$, $-C(O)N(R^\circ)_2$, $-OC(O)N(R^\circ)_2$, $-S(O)_2R^\circ$, $-SO_2N(R^\circ)_2$, $-S(O)R^\circ$, $-NR^\circ SO_2N(R^\circ)_2$, $-NR^\circ SO_2R^\circ$, $-C(=S)N(R^\circ)_2$, $-C(=NH)-N(R^\circ)_2$, $-(CH_2)_yNHC(O)R^\circ$, $-(CH_2)_yNHC(O)CH(V-R^\circ)(R^\circ)$; wherein R° is hydrogen, a substituted or unsubstituted aliphatic group, an unsubstituted heteroaryl or heterocyclic ring, phenyl (Ph), substituted Ph, $-O(Ph)$, substituted $-O(Ph)$, $-CH_2(Ph)$, or substituted $-CH_2(Ph)$; y is 0-6; and V is a linker group. Examples of substituents on the aliphatic group or the phenyl ring of R° include amino, alkylamino, dialkylamino, aminocarbonyl, halogen, alkyl, alkylaminocarbonyl, dialkylaminocarbonyl, alkylaminocarbonyloxy, dialkylaminocarbonyloxy, alkoxy, nitro, cyano, carboxy, alkoxycarbonyl, alkylcarbonyl, hydroxy, haloalkoxy, or haloalkyl.

An aliphatic group or a non-aromatic heterocyclic ring may contain one or more substituents.

Examples of suitable substituents on the saturated carbon of an aliphatic group or of a non-aromatic heterocyclic ring include those listed above for the unsaturated carbon of an aryl or heteroaryl group and the following:

5 =O, =S, =NNHR^{*}, =NN(R^{*})₂, =N-, =NNHC(O)R^{*}, =NNHCO₂(alkyl), =NNHSO₂(alkyl), or =NR^{*}, where each R^{*} is independently selected from hydrogen, an unsubstituted aliphatic group or a substituted aliphatic group. Examples of substituents on the aliphatic group include amino,

10 alkylamino, dialkylamino, aminocarbonyl, halogen, alkyl, alkylaminocarbonyl, dialkylaminocarbonyl, alkylaminocarbonyloxy, dialkylaminocarbonyloxy, alkoxy, nitro, cyano, carboxy, alkoxycarbonyl, alkylcarbonyl, hydroxy, haloalkoxy, or haloalkyl.

15 Suitable substituents on the nitrogen of a non-aromatic heterocyclic ring include -R^{*}, -N(R^{*})₂, -C(O)R^{*}, -CO₂R^{*}, -C(O)C(O)R^{*}, -C(O)CH₂C(O)R^{*}, -SO₂R^{*}, -SO₂N(R^{*})₂, -C(=S)N(R^{*})₂, -C(=NH)-N(R^{*})₂, and -NR^{*}SO₂R^{*}; wherein R^{*} is hydrogen, an aliphatic group, a substituted aliphatic

20 group, phenyl (Ph), substituted Ph, -O(Ph), substituted -O(Ph), CH₂(Ph), substituted CH₂(Ph), or an unsubstituted heteroaryl or heterocyclic ring. Examples of substituents on the aliphatic group or the phenyl ring include amino, alkylamino, dialkylamino, aminocarbonyl,

25 halogen, alkyl, alkylaminocarbonyl, dialkylaminocarbonyl, alkylaminocarbonyloxy, dialkylaminocarbonyloxy, alkoxy, nitro, cyano, carboxy, alkoxycarbonyl, alkylcarbonyl, hydroxy, haloalkoxy, or haloalkyl.

 The term "linker group" or "linker" means an

30 organic moiety that connects two parts of a compound. Linkers are typically comprised of an atom such as oxygen or sulfur, a unit such as -NH-, -CH₂-, -C(O)-, -C(O)NH-, or a chain of atoms, such as an alkylidene chain. The

molecular mass of a linker is typically in the range of about 14 to 200, preferably in the range of 14 to 96 with a length of up to about six atoms. Examples of linkers include a saturated or unsaturated C₁₋₆ alkylidene chain which is optionally substituted, and wherein one or two saturated carbons of the chain are optionally replaced by -C(O)-, -C(O)C(O)-, -CONH-, -CONHNH-, -CO₂-, -OC(O)-, -NHCO₂-, -O-, -NHCONH-, -OC(O)NH-, -NHNH-, -NHCO-, -S-, -SO-, -SO₂-, -NH-, -SO₂NH-, or -NHSO₂-.

10 The term "alkylidene chain" refers to an optionally substituted, straight or branched carbon chain that may be fully saturated or have one or more units of unsaturation. The optional substituents are as described above for an aliphatic group.

15 A combination of substituents or variables is permissible only if such a combination results in a stable or chemically feasible compound. A stable compound or chemically feasible compound is one in which the chemical structure is not substantially altered when
20 kept at a temperature of 40 °C or less, in the absence of moisture or other chemically reactive conditions, for at least a week.

 Unless otherwise stated, structures depicted herein are also meant to include all stereochemical forms
25 of the structure; i.e., the R and S configurations for each asymmetric center. Therefore, single stereochemical isomers as well as enantiomeric and diastereomeric mixtures of the present compounds are within the scope of the invention. Unless otherwise stated, structures
30 depicted herein are also meant to include compounds which differ only in the presence of one or more isotopically enriched atoms. For example, compounds having the present structures except for the replacement of a

hydrogen by a deuterium or tritium, or the replacement of a carbon by a ^{13}C - or ^{14}C -enriched carbon are within the scope of this invention.

Compounds of formula I or salts thereof may be
5 formulated into compositions. In a preferred embodiment, the composition is a pharmaceutical composition. In one embodiment, the composition comprises an amount of the protein kinase inhibitor effective to inhibit a protein kinase, particularly Aurora-2, in a biological sample or
10 in a patient. In another embodiment, compounds of this invention and pharmaceutical compositions thereof, which comprise an amount of the protein kinase inhibitor effective to treat or prevent an Aurora-2-mediated condition and a pharmaceutically acceptable carrier,
15 adjuvant, or vehicle, may be formulated for administration to a patient.

Another aspect of this invention relates to a method of treating or preventing an Aurora-2-mediated disease with an Aurora-2 inhibitor, which method
20 comprises administering to a patient in need of such a treatment a therapeutically effective amount of a compound of formula I or a pharmaceutical composition thereof.

The term "Aurora-2-mediated condition" or
25 "disease", as used herein, means any disease or other deleterious condition in which Aurora is known to play a role. The term "Aurora-2-mediated condition" or "disease" also means those diseases or conditions that are alleviated by treatment with an Aurora-2 inhibitor.
30 Such conditions include, without limitation, cancer. The term "cancer" includes, but is not limited to the following cancers: colon, breast, stomach, and ovarian.

Another aspect of the invention relates to inhibiting Aurora-2 activity in a biological sample, which method comprises contacting the biological sample with the Aurora-2 inhibitor of formula I, or a
5 composition thereof.

Another aspect of this invention relates to a method of inhibiting Aurora-2 activity in a patient, which method comprises administering to the patient a compound of formula I or a composition comprising said
10 compound.

Another aspect of this invention relates to a method of treating or preventing a GSK-3-mediated disease with a GSK-3 inhibitor, which method comprises administering to a patient in need of such a treatment a
15 therapeutically effective amount of a compound of formula I or a pharmaceutical composition thereof.

The term "GSK-3-mediated condition" or "disease", as used herein, means any disease or other deleterious condition or state in which GSK-3 is known to
20 play a role. Such diseases or conditions include, without limitation, diabetes, Alzheimer's disease, Huntington's Disease, Parkinson's Disease, AIDS-associated dementia, amyotrophic lateral sclerosis (AML), multiple sclerosis (MS), schizophrenia, cardiomyocyte
25 hypertrophy, reperfusion/ischemia, and baldness.

One aspect of this invention relates to a method of enhancing glycogen synthesis and/or lowering blood levels of glucose in a patient in need thereof, which method comprises administering to the patient a
30 therapeutically effective amount of a compound of formula I or a pharmaceutical composition thereof. This method is especially useful for diabetic patients. Another method relates to inhibiting the production of

hyperphosphorylated Tau protein, which is useful in halting or slowing the progression of Alzheimer's disease. Another method relates to inhibiting the phosphorylation of β -catenin, which is useful for
5 treating schizophrenia.

Another aspect of the invention relates to inhibiting GSK-3 activity in a biological sample, which method comprises contacting the biological sample with a GSK-3 inhibitor of formula I.

10 Another aspect of this invention relates to a method of inhibiting GSK-3 activity in a patient, which method comprises administering to the patient a compound of formula I or a composition comprising said compound.

The term "pharmaceutically acceptable carrier,
15 adjuvant, or vehicle" refers to a non-toxic carrier, adjuvant, or vehicle that may be administered to a patient, together with a compound of this invention, and which does not destroy the pharmacological activity thereof.

20 The term "patient" includes human and veterinary subjects.

The term "biological sample", as used herein, includes, without limitation, cell cultures or extracts thereof; preparations of an enzyme suitable for *in vitro*
25 assay; biopsied material obtained from a mammal or extracts thereof; and blood, saliva, urine, feces, semen, tears, or other body fluids or extracts thereof.

The amount effective to inhibit protein kinase, for example, Aurora-2 and GSK-3, is one that measurably
30 inhibits the kinase activity where compared to the activity of the enzyme in the absence of an inhibitor. Any method may be used to determine inhibition, such as,

for example, the Biological Testing Examples described below.

Pharmaceutically acceptable carriers that may be used in these pharmaceutical compositions include, but
5 are not limited to, ion exchangers, alumina, aluminum stearate, lecithin, serum proteins, such as human serum albumin, buffer substances such as phosphates, glycine, sorbic acid, potassium sorbate, partial glyceride mixtures of saturated vegetable fatty acids, water, salts
10 or electrolytes, such as protamine sulfate, disodium hydrogen phosphate, potassium hydrogen phosphate, sodium chloride, zinc salts, colloidal silica, magnesium trisilicate, polyvinyl pyrrolidone, cellulose-based substances, polyethylene glycol, sodium
15 carboxymethylcellulose, polyacrylates, waxes, polyethylene-polyoxypropylene-block polymers, polyethylene glycol and wool fat.

The compositions of the present invention may be administered orally, parenterally, by inhalation
20 spray, topically, rectally, nasally, buccally, vaginally or via an implanted reservoir. The term "parenteral" as used herein includes subcutaneous, intravenous, intramuscular, intra-articular, intra-synovial, intrasternal, intrathecal, intrahepatic, intralesional
25 and intracranial injection or infusion techniques. Preferably, the compositions are administered orally, intraperitoneally or intravenously.

Sterile injectable forms of the compositions of this invention may be aqueous or oleaginous suspension.
30 These suspensions may be formulated according to techniques known in the art using suitable dispersing or wetting agents and suspending agents. The sterile injectable preparation may also be a sterile injectable

solution or suspension in a non-toxic parenterally-acceptable diluent or solvent, for example as a solution in 1,3-butanediol. Among the acceptable vehicles and solvents that may be employed are water, Ringer's
5 solution and isotonic sodium chloride solution. In addition, sterile, fixed oils are conventionally employed as a solvent or suspending medium. For this purpose, any bland fixed oil may be employed including synthetic mono- or di-glycerides. Fatty acids, such as oleic acid and
10 its glyceride derivatives are useful in the preparation of injectables, as are natural pharmaceutically-acceptable oils, such as olive oil or castor oil, especially in their polyoxyethylated versions. These oil solutions or suspensions may also contain a long-chain
15 alcohol diluent or dispersant, such as carboxymethyl cellulose or similar dispersing agents which are commonly used in the formulation of pharmaceutically acceptable dosage forms including emulsions and suspensions. Other commonly used surfactants, such as Tweens, Spans and
20 other emulsifying agents or bioavailability enhancers which are commonly used in the manufacture of pharmaceutically acceptable solid, liquid, or other dosage forms may also be used for the purposes of formulation.

25 The pharmaceutical compositions of this invention may be orally administered in any orally acceptable dosage form including, but not limited to, capsules, tablets, aqueous suspensions or solutions. In the case of tablets for oral use, carriers commonly used
30 include lactose and corn starch. Lubricating agents, such as magnesium stearate, are also typically added. For oral administration in a capsule form, useful diluents include lactose and dried cornstarch. When

aqueous suspensions are required for oral use, the active ingredient is combined with emulsifying and suspending agents. If desired, certain sweetening, flavoring or coloring agents may also be added.

5 Alternatively, the pharmaceutical compositions of this invention may be administered in the form of suppositories for rectal administration. These can be prepared by mixing the agent with a suitable non-irritating excipient which is solid at room temperature
10 but liquid at rectal temperature and therefore will melt in the rectum to release the drug. Such materials include cocoa butter, beeswax and polyethylene glycols.

 The pharmaceutical compositions of this invention may also be administered topically, especially
15 when the target of treatment includes areas or organs readily accessible by topical application, including diseases of the eye, the skin, or the lower intestinal tract. Suitable topical formulations are readily prepared for each of these areas or organs.

20 Topical application for the lower intestinal tract can be effected in a rectal suppository formulation (see above) or in a suitable enema formulation. Topically-transdermal patches may also be used.

 For topical applications, the pharmaceutical
25 compositions may be formulated in a suitable ointment containing the active component suspended or dissolved in one or more carriers. Carriers for topical administration of the compounds of this invention include, but are not limited to, mineral oil, liquid
30 petrolatum, white petrolatum, propylene glycol, polyoxyethylene, polyoxypropylene compound, emulsifying wax and water. Alternatively, the pharmaceutical compositions can be formulated in a suitable lotion or

cream containing the active components suspended or dissolved in one or more pharmaceutically acceptable carriers. Suitable carriers include, but are not limited to, mineral oil, sorbitan monostearate, polysorbate 60, 5 cetyl esters wax, cetearyl alcohol, 2-octyldodecanol, benzyl alcohol and water.

For ophthalmic use, the pharmaceutical compositions may be formulated as micronized suspensions in isotonic, pH adjusted sterile saline, or, preferably, 10 as solutions in isotonic, pH adjusted sterile saline, either with or without a preservative such as benzylalkonium chloride. Alternatively, for ophthalmic uses, the pharmaceutical compositions may be formulated in an ointment such as petrolatum.

15 The pharmaceutical compositions of this invention may also be administered by nasal aerosol or inhalation. Such compositions are prepared according to techniques well-known in the art of pharmaceutical formulation and may be prepared as solutions in saline, 20 employing benzyl alcohol or other suitable preservatives, absorption promoters to enhance bioavailability, fluorocarbons, and/or other conventional solubilizing or dispersing agents.

In addition to the compounds of this invention, 25 pharmaceutically acceptable derivatives or prodrugs of the compounds of this invention may also be employed in compositions to treat or prevent the above-identified diseases or disorders.

A "pharmaceutically acceptable derivative or 30 prodrug" means any pharmaceutically acceptable salt, ester, salt of an ester or other derivative of a compound of this invention which, upon administration to a recipient, is capable of providing, either directly or

indirectly, a compound of this invention or an inhibitorily active metabolite or residue thereof. Particularly favored derivatives or prodrugs are those that increase the bioavailability of the compounds of this invention when such compounds are administered to a patient (e.g., by allowing an orally administered compound to be more readily absorbed into the blood) or which enhance delivery of the parent compound to a biological compartment (e.g., the brain or lymphatic system) relative to the parent species.

Pharmaceutically acceptable prodrugs of the compounds of this invention include, without limitation, esters, amino acid esters, phosphate esters, metal salts and sulfonate esters.

Pharmaceutically acceptable salts of the compounds of this invention include those derived from pharmaceutically acceptable inorganic and organic acids and bases. Examples of suitable acid salts include acetate, adipate, alginate, aspartate, benzoate, benzenesulfonate, bisulfate, butyrate, citrate, camphorate, camphorsulfonate, cyclopentanepropionate, digluconate, dodecylsulfate, ethanesulfonate, formate, fumarate, glucoheptanoate, glycerophosphate, glycolate, hemisulfate, heptanoate, hexanoate, hydrochloride, hydrobromide, hydroiodide, 2-hydroxyethanesulfonate, lactate, maleate, malonate, methanesulfonate, 2-naphthalenesulfonate, nicotinate, nitrate, oxalate, palmoate, pectinate, persulfate, 3-phenylpropionate, phosphate, picrate, pivalate, propionate, salicylate, succinate, sulfate, tartrate, thiocyanate, tosylate and undecanoate. Other acids, such as oxalic, while not in themselves pharmaceutically acceptable, may be employed in the preparation of salts useful as intermediates in

obtaining the compounds of the invention and their pharmaceutically acceptable acid addition salts.

Salts derived from appropriate bases include alkali metal (e.g., sodium and potassium), alkaline earth
5 metal (e.g., magnesium), ammonium and $N^+(C_{1-4} \text{ alkyl})_4$ salts. This invention also envisions the quaternization of any basic nitrogen-containing groups of the compounds disclosed herein. Water or oil-soluble or dispersible products may be obtained by such quaternization.

10 The amount of the protein kinase inhibitor that may be combined with the carrier materials to produce a single dosage form will vary depending upon the patient treated and the particular mode of administration. Preferably, the compositions should be formulated so that
15 a dosage of between 0.01 - 100 mg/kg body weight/day of the inhibitor can be administered to a patient receiving these compositions.

It should also be understood that a specific dosage and treatment regimen for any particular patient
20 will depend upon a variety of factors, including the activity of the specific compound employed, the age, body weight, general health, sex, diet, time of administration, rate of excretion, drug combination, and the judgment of the treating physician and the severity
25 of the particular disease being treated. The amount of the inhibitor will also depend upon the particular compound in the composition.

Depending upon the particular protein kinase-mediated condition to be treated or prevented, additional
30 therapeutic agents, which are normally administered to treat or prevent that condition, may be administered together with the inhibitors of this invention. For example, in the treatment of cancer other

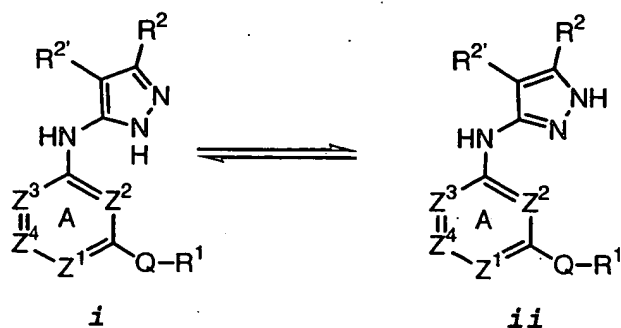
chemotherapeutic agents or other anti-proliferative agents may be combined with the Aurora-2 inhibitors of this invention to treat cancer. These agents include, without limitation, adriamycin, dexamethasone,
5 vincristine, cyclophosphamide, fluorouracil, topotecan, taxol, interferons, and platinum derivatives.

Other examples of agents the inhibitors of this invention may also be combined with include, without limitation, agents for treating diabetes such as insulin
10 or insulin analogues, in injectable or inhalation form, glitazones, alpha glucosidase inhibitors, biguanides, insulin sensitizers, and sulfonyl ureas; anti-inflammatory agents such as corticosteroids, TNF blockers, IL-1 RA, azathioprine, cyclophosphamide, and
15 sulfasalazine; immunomodulatory and immunosuppressive agents such as cyclosporin, tacrolimus, rapamycin, mycophenolate mofetil, interferons, corticosteroids, cyclophosphamide, azathioprine, and sulfasalazine; neurotrophic factors such as acetylcholinesterase
20 inhibitors, MAO inhibitors, interferons, anti-convulsants, ion channel blockers, riluzole, and anti-Parkinsonian agents; agents for treating cardiovascular disease such as beta-blockers, ACE inhibitors, diuretics, nitrates, calcium channel blockers, and statins; agents
25 for treating liver disease such as corticosteroids, cholestyramine, interferons, and anti-viral agents; agents for treating blood disorders such as corticosteroids, anti-leukemic agents, and growth factors; and agents for treating immunodeficiency
30 disorders such as gamma globulin.

Those additional agents may be administered separately from the protein kinase inhibitor-containing composition, as part of a multiple dosage regimen.

Alternatively, those agents may be part of a single dosage form, mixed together with the protein kinase inhibitor of this invention in a single composition.

Compounds of this invention may exist in alternative tautomeric forms, as in tautomers *i* and *ii* shown below. Unless otherwise indicated, the representation of either tautomer is meant to include the other.

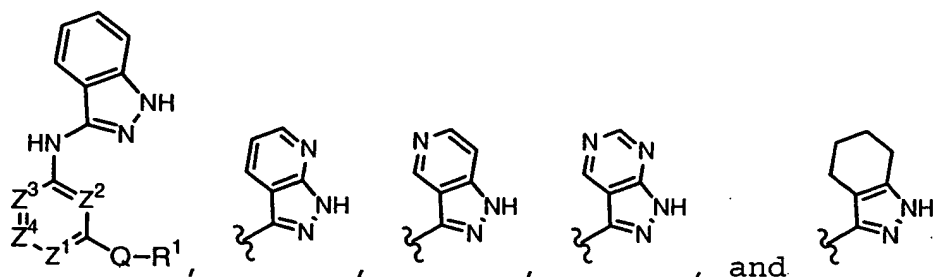


Preferred R^x groups, when present, include hydrogen, alkyl- or dialkylamino, acetamido, or a C_{1-4} aliphatic group such as methyl, ethyl, cyclopropyl, or isopropyl.

Preferred R^y groups, when present, include $Z-R^{3'}$ or an optionally substituted group selected from C_{1-6} aliphatic, 5-6 membered heterocyclyl, phenyl, or 5-6 membered heteroaryl, wherein Z is a methylene and $R^{3'}$ is $-N(R^4)_2$, $-OR$, or an optionally substituted group selected from C_{1-6} aliphatic, C_{6-10} aryl, a heteroaryl ring having 5-10 ring atoms, or a heterocyclyl ring having 5-10 ring atoms. Preferred R^y groups include 5-6 membered heteroaryl or heterocyclyl rings, such as 2-pyridyl, 4-pyridyl, pyrrolidinyl, piperidinyl, morpholinyl, or piperazinyl; C_{1-6} aliphatic, such as methyl, ethyl, cyclopropyl, isopropyl, or t-butyl; alkoxyalkylamino such

as methoxyethylamino;, alkoxyalkyl such as methoxymethyl or methoxyethyl; alkyl- or dialkylamino such as ethylamino or dimethylamino; alkyl- or dialkylaminoalkoxy such as dimethylaminopropoxy; acetamido; and optionally
 5 substituted phenyl such as phenyl or halo-substituted phenyl.

R^2 and $R^{2'}$ may be taken together to form a fused ring, thus providing a bicyclic ring system containing a pyrazole ring. Preferred fused rings include benzo,
 10 pyrido, pyrimido, and a partially unsaturated 6-membered carbocyclo ring, wherein said fused ring is optionally substituted. These are exemplified in the following formula I compounds having a pyrazole-containing bicyclic ring system:



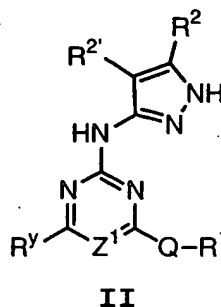
15 Preferred substituents on the $R^2/R^{2'}$ fused ring include one or more of the following: -halo, $-N(R^4)_2$, $-C_{1-3}$ alkyl, $-C_{1-3}$ haloalkyl, $-NO_2$, $-O(C_{1-3}$ alkyl), $-CO_2(C_{1-3}$ alkyl), $-CN$, $-SO_2(C_{1-3}$ alkyl), $-SO_2NH_2$, $-OC(O)NH_2$, $-NH_2SO_2(C_{1-3}$ alkyl), $-NHC(O)(C_{1-3}$ alkyl), $-C(O)NH_2$, and
 20 $-CO(C_{1-3}$ alkyl), wherein the $(C_{1-3}$ alkyl) is most preferably methyl.

When the pyrazole ring system is monocyclic, preferred R^2 groups include hydrogen, C_{1-4} aliphatic, alkoxy carbonyl, (un)substituted phenyl, hydroxyalkyl,
 25 alkoxyalkyl, aminocarbonyl, mono- or

dialkylaminocarbonyl, aminoalkyl, alkylaminoalkyl, dialkylaminoalkyl, phenylaminocarbonyl, and (N-heterocyclyl)carbonyl. Examples of such preferred R² substituents include methyl, cyclopropyl, ethyl, isopropyl, propyl, t-butyl, cyclopentyl, phenyl, CO₂H, CO₂CH₃, CH₂OH, CH₂OCH₃, CH₂CH₂CH₂OH, CH₂CH₂CH₂OCH₃, CH₂CH₂CH₂OCH₂Ph, CH₂CH₂CH₂NH₂, CH₂CH₂CH₂NHCOOC(CH₃)₃, CONHCH(CH₃)₂, CONHCH₂CH=CH₂, CONHCH₂CH₂OCH₃, CONHCH₂Ph, CONH(cyclohexyl), CON(ET)₂, CON(CH₃)CH₂Ph, CONH(n-C₃H₇), CON(ET)CH₂CH₂CH₃, CONHCH₂CH(CH₃)₂, CON(n-C₃H₇)₂, CO(3-methoxymethylpyrrolidin-1-yl), CONH(3-tolyl), CONH(4-tolyl), CONHCH₃, CO(morpholin-1-yl), CO(4-methylpiperazin-1-yl), CONHCH₂CH₂OH, CONH₂, and CO(piperidin-1-yl). A preferred R^{2'} group is hydrogen.

Preferred Q groups of formula I include -S-, -NH-, and -CH₂-. More preferred Q groups of formula I include -S- and -NH-.

Another embodiment of this invention relates to compounds of formula II:



or a pharmaceutically acceptable derivative or prodrug thereof, wherein:

Z¹ is nitrogen or CR⁸;

R^y is Z-R^{3'} or an optionally substituted group selected from C₁₋₆ aliphatic, C₆₋₁₀ aryl, a heteroaryl ring having

5-10 ring atoms, or a heterocyclyl ring having 5-10

ring atoms, or R^y and R^8 are taken together to form a fused, optionally substituted 5-7 membered, unsaturated or partially unsaturated, ring having 0-3 ring heteroatoms selected from nitrogen, oxygen, or sulfur;

5 Q is selected from $-N(R^4)-$, $-O-$, $-S-$, or $-CH(R^6)-$;

R^1 is T-(Ring D);

Ring D is a 5-7 membered monocyclic ring or 8-10 membered bicyclic ring selected from aryl, heteroaryl, heterocyclyl or carbocyclyl, said heteroaryl or
10 heterocyclyl ring having 1-4 ring heteroatoms selected from nitrogen, oxygen or sulfur, wherein each substitutable ring carbon of Ring D is independently substituted by oxo, $T-R^5$, or $V-Z-R^5$, and each substitutable ring nitrogen of Ring D is independently
15 substituted by $-R^4$;

T is a valence bond or a C_{1-4} alkylidene chain, wherein when Q is $-CH(R^6)-$, a methylene unit of said C_{1-4} alkylidene chain is optionally replaced by $-O-$, $-S-$, $-N(R^4)-$, $-CO-$, $-CONH-$, $-NHCO-$, $-SO_2-$, $-SO_2NH-$, $-NHSO_2-$,
20 $-CO_2-$, $-OC(O)-$, $-OC(O)NH-$, or $-NHCO_2-$;

Z is a C_{1-4} alkylidene chain;

L is $-O-$, $-S-$, $-SO-$, $-SO_2-$, $-N(R^6)SO_2-$, $-SO_2N(R^6)-$,
 $-N(R^6)-$, $-CO-$, $-CO_2-$, $-N(R^6)CO-$, $-N(R^6)C(O)O-$,
 $-N(R^6)CON(R^6)-$, $-N(R^6)SO_2N(R^6)-$, $-N(R^6)N(R^6)-$,
25 $-C(O)N(R^6)-$, $-OC(O)N(R^6)-$, $-C(R^6)_2O-$, $-C(R^6)_2S-$,
 $-C(R^6)_2SO-$, $-C(R^6)_2SO_2-$, $-C(R^6)_2SO_2N(R^6)-$, $-C(R^6)_2N(R^6)-$,
 $-C(R^6)_2N(R^6)C(O)-$, $-C(R^6)_2N(R^6)C(O)O-$, $-C(R^6)=NN(R^6)-$,
 $-C(R^6)=N-O-$, $-C(R^6)_2N(R^6)N(R^6)-$, $-C(R^6)_2N(R^6)SO_2N(R^6)-$, or
 $-C(R^6)_2N(R^6)CON(R^6)-$;

30 R^2 and $R^{2'}$ are independently selected from $-R$, $-T-W-R^6$, or
 R^2 and $R^{2'}$ are taken together with their intervening atoms to form a fused, 5-8 membered, unsaturated or partially unsaturated, ring having 0-3 ring heteroatoms

- selected from nitrogen, oxygen, or sulfur, wherein each substitutable ring carbon of said fused ring formed by R^2 and $R^{2'}$ is independently substituted by halo, oxo, -CN, -NO₂, -R⁷, or -V-R⁶, and each substitutable ring
- 5 nitrogen of said ring formed by R^2 and $R^{2'}$ is independently substituted by R⁴;
- R^{3'} is selected from -halo, -OR, -C(=O)R, -CO₂R, -COCOR, -COCH₂COR, -NO₂, -CN, -S(O)R, -S(O)₂R, -SR, -N(R⁴)₂, -CON(R⁷)₂, -SO₂N(R⁷)₂, -OC(=O)R, -N(R⁷)COR, -N(R⁷)CO₂(C₁₋₆
- 10 aliphatic), -N(R⁴)N(R⁴)₂, -C=NN(R⁴)₂, -C=N-OR, -N(R⁷)CON(R⁷)₂, -N(R⁷)SO₂N(R⁷)₂, -N(R⁴)SO₂R, -OC(=O)N(R⁷)₂, or an optionally substituted group selected from C₁₋₆ aliphatic, C₆₋₁₀ aryl, a heteroaryl ring having 5-10 ring atoms, or a heterocyclyl ring
- 15 having 5-10 ring atoms;
- each R is independently selected from hydrogen or an optionally substituted group selected from C₁₋₆ aliphatic, C₆₋₁₀ aryl, a heteroaryl ring having 5-10 ring atoms, or a heterocyclyl ring having 5-10 ring
- 20 atoms;
- each R⁴ is independently selected from -R⁷, -COR⁷, -CO₂(optionally substituted C₁₋₆ aliphatic), -CON(R⁷)₂, or -SO₂R⁷;
- each R⁵ is independently selected from -R, halo, -OR,
- 25 -C(=O)R, -CO₂R, -COCOR, -NO₂, -CN, -S(O)R, -SO₂R, -SR, -N(R⁴)₂, -CON(R⁴)₂, -SO₂N(R⁴)₂, -OC(=O)R, -N(R⁴)COR, -N(R⁴)CO₂(optionally substituted C₁₋₆ aliphatic), -N(R⁴)N(R⁴)₂, -C=NN(R⁴)₂, -C=N-OR, -N(R⁴)CON(R⁴)₂, -N(R⁴)SO₂N(R⁴)₂, -N(R⁴)SO₂R, or -OC(=O)N(R⁴)₂;
- 30 V is -O-, -S-, -SO-, -SO₂-, -N(R⁶)SO₂-, -SO₂N(R⁶)-, -N(R⁶)-, -CO-, -CO₂-, -N(R⁶)CO-, -N(R⁶)C(O)O-, -N(R⁶)CON(R⁶)-, -N(R⁶)SO₂N(R⁶)-, -N(R⁶)N(R⁶)-, -C(O)N(R⁶)-, -OC(O)N(R⁶)-, -C(R⁶)₂O-, -C(R⁶)₂S-,

$-C(R^6)_2SO-$, $-C(R^6)_2SO_2-$, $-C(R^6)_2SO_2N(R^6)-$, $-C(R^6)_2N(R^6)-$,
 $-C(R^6)_2N(R^6)C(O)-$, $-C(R^6)_2N(R^6)C(O)O-$, $-C(R^6)=NN(R^6)-$,
 $-C(R^6)=N-O-$, $-C(R^6)_2N(R^6)N(R^6)-$, $-C(R^6)_2N(R^6)SO_2N(R^6)-$, or
 $-C(R^6)_2N(R^6)CON(R^6)-$;

- 5 W is $-C(R^6)_2O-$, $-C(R^6)_2S-$, $-C(R^6)_2SO-$, $-C(R^6)_2SO_2-$,
 $-C(R^6)_2SO_2N(R^6)-$, $-C(R^6)_2N(R^6)-$, $-CO-$, $-CO_2-$,
 $-C(R^6)OC(O)-$, $-C(R^6)OC(O)N(R^6)-$, $-C(R^6)_2N(R^6)CO-$,
 $-C(R^6)_2N(R^6)C(O)O-$, $-C(R^6)=NN(R^6)-$, $-C(R^6)=N-O-$,
 $-C(R^6)_2N(R^6)N(R^6)-$, $-C(R^6)_2N(R^6)SO_2N(R^6)-$,
10 $-C(R^6)_2N(R^6)CON(R^6)-$, or $-CON(R^6)-$;

each R^6 is independently selected from hydrogen or an
optionally substituted C_{1-4} aliphatic group, or two R^6
groups on the same nitrogen atom are taken together
with the nitrogen atom to form a 5-6 membered

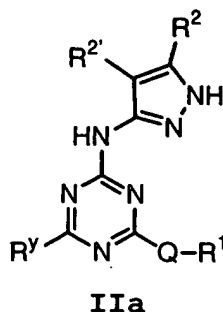
- 15 heterocyclyl or heteroaryl ring;

each R^7 is independently selected from hydrogen or an
optionally substituted C_{1-6} aliphatic group, or two R^7
on the same nitrogen are taken together with the
nitrogen to form a 5-8 membered heterocyclyl or

- 20 heteroaryl ring; and

R^8 is selected from $-R$, halo, $-OR$, $-C(=O)R$, $-CO_2R$, $-COCOR$,
 $-NO_2$, $-CN$, $-S(O)R$, $-SO_2R$, $-SR$, $-N(R^4)_2$, $-CON(R^4)_2$,
 $-SO_2N(R^4)_2$, $-OC(=O)R$, $-N(R^4)COR$, $-N(R^4)CO_2$ (optionally
substituted C_{1-6} aliphatic), $-N(R^4)N(R^4)_2$, $-C=NN(R^4)_2$,
25 $-C=N-OR$, $-N(R^4)CON(R^4)_2$, $-N(R^4)SO_2N(R^4)_2$, $-N(R^4)SO_2R$, or
 $-OC(=O)N(R^4)_2$; provided that when Q is $-NH-$ and R^7 and
 R^8 are taken together to form a fused ring, R^1 is other
than a pyrazol-3-yl ring or a pyrazol-3-yl-containing
bicyclic ring system.

- 30 Another embodiment of this invention relates to
compounds of formula IIa:



or a pharmaceutically acceptable derivative or prodrug thereof, wherein:

R^Y is $Z-R^{3'}$ or an optionally substituted group selected from C_{1-6} aliphatic, C_{6-10} aryl, a heteroaryl ring having 5-10 ring atoms, or a heterocyclyl ring having 5-10 ring atoms;

Q is selected from $-N(R^4)-$, $-O-$, $-S-$, or $-CH(R^6)-$;

R^1 is T-(Ring D);

Ring D is a 5-7 membered monocyclic ring or 8-10 membered bicyclic ring selected from aryl, heteroaryl, heterocyclyl or carbocyclyl, said heteroaryl or heterocyclyl ring having 1-4 ring heteroatoms selected from nitrogen, oxygen or sulfur, wherein each substitutable ring carbon of Ring D is independently substituted by oxo, $T-R^5$, or $V-Z-R^5$, and each substitutable ring nitrogen of Ring D is independently substituted by $-R^4$;

T is a valence bond or a C_{1-4} alkylidene chain, wherein when Q is $-CH(R^6)-$, a methylene unit of said C_{1-4} alkylidene chain is optionally replaced by $-O-$, $-S-$, $-N(R^4)-$, $-CO-$, $-CONH-$, $-NHCO-$, $-SO_2-$, $-SO_2NH-$, $-NHSO_2-$, $-CO_2-$, $-OC(O)-$, $-OC(O)NH-$, or $-NHCO_2-$;

Z is a C_{1-4} alkylidene chain;

L is $-O-$, $-S-$, $-SO-$, $-SO_2-$, $-N(R^6)SO_2-$, $-SO_2N(R^6)-$, $-N(R^6)-$, $-CO-$, $-CO_2-$, $-N(R^6)CO-$, $-N(R^6)C(O)O-$, $-N(R^6)CON(R^6)-$, $-N(R^6)SO_2N(R^6)-$, $-N(R^6)N(R^6)-$,

- $-C(O)N(R^6)-$, $-OC(O)N(R^6)-$, $-C(R^6)_2O-$, $-C(R^6)_2S-$,
 $-C(R^6)_2SO-$, $-C(R^6)_2SO_2-$, $-C(R^6)_2SO_2N(R^6)-$, $-C(R^6)_2N(R^6)-$,
 $-C(R^6)_2N(R^6)C(O)-$, $-C(R^6)_2N(R^6)C(O)O-$, $-C(R^6)=NN(R^6)-$,
 $-C(R^6)=N-O-$, $-C(R^6)_2N(R^6)N(R^6)-$, $-C(R^6)_2N(R^6)SO_2N(R^6)-$, or
 5 $-C(R^6)_2N(R^6)CON(R^6)-$;
- R^2 and $R^{2'}$ are independently selected from $-R$, $-T-W-R^6$, or
 R^2 and $R^{2'}$ are taken together with their intervening
 atoms to form a fused, 5-8 membered, unsaturated or
 partially unsaturated, ring having 0-3 ring heteroatoms
 10 selected from nitrogen, oxygen, or sulfur, wherein each
 substitutable ring carbon of said fused ring formed by
 R^2 and $R^{2'}$ is independently substituted by halo, oxo,
 $-CN$, $-NO_2$, $-R^7$, or $-V-R^6$, and each substitutable ring
 nitrogen of said ring formed by R^2 and $R^{2'}$ is
 15 independently substituted by R^4 ;
- $R^{3'}$ is selected from $-halo$, $-OR$, $-C(=O)R$, $-CO_2R$, $-COCOR$,
 $-COCH_2COR$, $-NO_2$, $-CN$, $-S(O)R$, $-S(O)_2R$, $-SR$, $-N(R^4)_2$,
 $-CON(R^7)_2$, $-SO_2N(R^7)_2$, $-OC(=O)R$, $-N(R^7)COR$, $-N(R^7)CO_2(C_{1-6}$
 aliphatic), $-N(R^4)N(R^4)_2$, $-C=NN(R^4)_2$, $-C=N-OR$,
 20 $-N(R^7)CON(R^7)_2$, $-N(R^7)SO_2N(R^7)_2$, $-N(R^4)SO_2R$,
 $-OC(=O)N(R^7)_2$, or an optionally substituted group
 selected from C_{1-6} aliphatic, C_{6-10} aryl, a heteroaryl
 ring having 5-10 ring atoms, or a heterocyclyl ring
 having 5-10 ring atoms;
- 25 each R is independently selected from hydrogen or an
 optionally substituted group selected from C_{1-6}
 aliphatic, C_{6-10} aryl, a heteroaryl ring having 5-10
 ring atoms, or a heterocyclyl ring having 5-10 ring
 atoms;
- 30 each R^4 is independently selected from $-R^7$, $-COR^7$,
 $-CO_2$ (optionally substituted C_{1-6} aliphatic), $-CON(R^7)_2$,
 or $-SO_2R^7$;

- each R^5 is independently selected from -R, halo, -OR,
 -C(=O)R, -CO₂R, -COCOR, -NO₂, -CN, -S(O)R, -SO₂R, -SR,
 -N(R⁴)₂, -CON(R⁴)₂, -SO₂N(R⁴)₂, -OC(=O)R, -N(R⁴)COR,
 -N(R⁴)CO₂(optionally substituted C₁₋₆ aliphatic),
 5 -N(R⁴)N(R⁴)₂, -C=NN(R⁴)₂, -C=N-OR, -N(R⁴)CON(R⁴)₂,
 -N(R⁴)SO₂N(R⁴)₂, -N(R⁴)SO₂R, or -OC(=O)N(R⁴)₂;
 V is -O-, -S-, -SO-, -SO₂-, -N(R⁶)SO₂-, -SO₂N(R⁶)-,
 -N(R⁶)-, -CO-, -CO₂-, -N(R⁶)CO-, -N(R⁶)C(O)O-,
 -N(R⁶)CON(R⁶)-, -N(R⁶)SO₂N(R⁶)-, -N(R⁶)N(R⁶)-,
 10 -C(O)N(R⁶)-, -OC(O)N(R⁶)-, -C(R⁶)₂O-, -C(R⁶)₂S-,
 -C(R⁶)₂SO-, -C(R⁶)₂SO₂-, -C(R⁶)₂SO₂N(R⁶)-, -C(R⁶)₂N(R⁶)-,
 -C(R⁶)₂N(R⁶)C(O)-, -C(R⁶)₂N(R⁶)C(O)O-, -C(R⁶)=NN(R⁶)-,
 -C(R⁶)=N-O-, -C(R⁶)₂N(R⁶)N(R⁶)-, -C(R⁶)₂N(R⁶)SO₂N(R⁶)-, or
 -C(R⁶)₂N(R⁶)CON(R⁶)-;
 15 W is -C(R⁶)₂O-, -C(R⁶)₂S-, -C(R⁶)₂SO-, -C(R⁶)₂SO₂-,
 -C(R⁶)₂SO₂N(R⁶)-, -C(R⁶)₂N(R⁶)-, -CO-, -CO₂-,
 -C(R⁶)OC(O)-, -C(R⁶)OC(O)N(R⁶)-, -C(R⁶)₂N(R⁶)CO-,
 -C(R⁶)₂N(R⁶)C(O)O-, -C(R⁶)=NN(R⁶)-, -C(R⁶)=N-O-,
 -C(R⁶)₂N(R⁶)N(R⁶)-, -C(R⁶)₂N(R⁶)SO₂N(R⁶)-,
 20 -C(R⁶)₂N(R⁶)CON(R⁶)-, or -CON(R⁶)-;

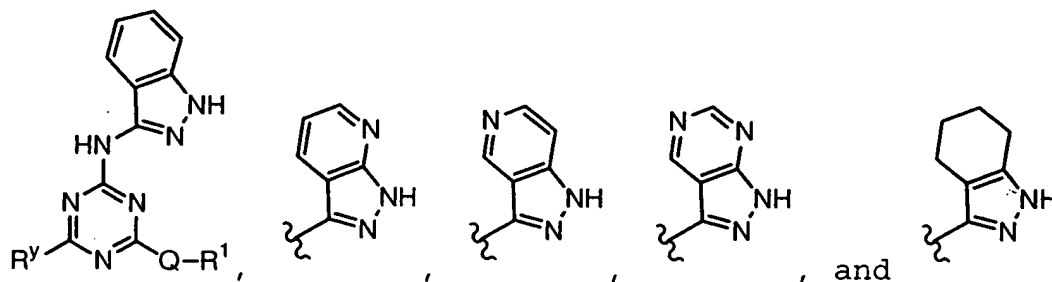
- each R^6 is independently selected from hydrogen or an
 optionally substituted C₁₋₄ aliphatic group, or two R^6
 groups on the same nitrogen atom are taken together
 with the nitrogen atom to form a 5-6 membered
 25 heterocyclyl or heteroaryl ring; and
 each R^7 is independently selected from hydrogen or an
 optionally substituted C₁₋₆ aliphatic group, or two R^7
 on the same nitrogen are taken together with the
 nitrogen to form a 5-8 membered heterocyclyl or
 30 heteroaryl ring.

Preferred R^y groups of formula IIa include Z- $R^{3'}$
 or an optionally substituted group selected from C₁₋₆
 aliphatic, 5-6 membered heterocyclyl, phenyl, or 5-6

membered heteroaryl, wherein Z is a methylene and R^{3'} is
 -N(R⁴)₂, -OR, or an optionally substituted group selected
 from C₁₋₆ aliphatic, C₆₋₁₀ aryl, a heteroaryl ring having
 5-10 ring atoms, or a heterocyclyl ring having 5-10 ring
 5 atoms.

Examples of preferred R^y groups include
 2-pyridyl, 4-pyridyl, pyrrolidinyl, piperidinyl,
 morpholinyl, piperazinyl, methyl, ethyl, cyclopropyl,
 isopropyl, t-butyl, alkoxyalkylamino such as
 10 methoxyethylamino, alkoxyalkyl such as methoxymethyl or
 methoxyethyl, alkyl- or dialkylamino such as ethylamino
 or dimethylamino, alkyl- or dialkylaminoalkoxy such as
 dimethylaminopropoxy, acetamido, optionally substituted
 phenyl such as phenyl or halo-substituted phenyl.

15 The R² and R^{2'} groups of formula IIa may be
 taken together to form a fused ring, thus providing a
 bicyclic ring system containing a pyrazole ring.
 Preferred fused rings include benzo, pyrido, pyrimido,
 and a partially unsaturated 6-membered carbocyclo ring.
 20 These are exemplified in the following formula IIa
 compounds having a pyrazole-containing bicyclic ring
 system:



Preferred substituents on the R²/R^{2'} fused ring
 of formula IIa include one or more of the following:
 25 -halo, -N(R⁴)₂, -C₁₋₄ alkyl, -C₁₋₄ haloalkyl, -NO₂, -O(C₁₋₄

alkyl), $-\text{CO}_2(\text{C}_{1-4} \text{ alkyl})$, $-\text{CN}$, $-\text{SO}_2(\text{C}_{1-4} \text{ alkyl})$, $-\text{SO}_2\text{NH}_2$,
 $-\text{OC}(\text{O})\text{NH}_2$, $-\text{NH}_2\text{SO}_2(\text{C}_{1-4} \text{ alkyl})$, $-\text{NHC}(\text{O})(\text{C}_{1-4} \text{ alkyl})$,
 $-\text{C}(\text{O})\text{NH}_2$, and $-\text{CO}(\text{C}_{1-4} \text{ alkyl})$, wherein the $(\text{C}_{1-4} \text{ alkyl})$ is a
straight, branched, or cyclic alkyl group. Preferably,
5 the $(\text{C}_{1-4} \text{ alkyl})$ group is methyl.

When the pyrazole ring system of formula IIa is
monocyclic, preferred R^2 groups include hydrogen or a
substituted or unsubstituted group selected from aryl,
heteroaryl, or a C_{1-6} aliphatic group. Examples of such
10 preferred R^2 groups include H, methyl, ethyl, propyl, ,
cyclopropyl, i-propyl, cyclopentyl, hydroxypropyl,
methoxypropyl, and benzyloxypropyl. A preferred $\text{R}^{2'}$ group
is hydrogen.

When Ring D of formula IIa is monocyclic,
15 preferred Ring D groups include phenyl, pyridyl,
pyridazinyl, pyrimidinyl, and pyrazinyl.

When Ring D of formula IIa is bicyclic,
preferred bicyclic Ring D groups include naphthyl,
tetrahydronaphthyl, indanyl, benzimidazolyl, quinolinyl,
20 indolyl, isoindolyl, indolinyl, benzo[b]furyl,
benzo[b]thiophenyl, indazolyl, benzothiazolyl,
cinnolinyl, phthalazinyl, quinazolinyl, quinoxazolinyl,
1,8-naphthyridinyl and isoquinolinyl.

On Ring D of formula IIa, preferred T-R^5 or
25 V-Z-R^5 substituents include -halo, $-\text{CN}$, $-\text{NO}_2$, $-\text{N}(\text{R}^4)_2$,
optionally substituted C_{1-6} aliphatic group, $-\text{OR}$, $-\text{C}(\text{O})\text{R}$,
 $-\text{CO}_2\text{R}$, $-\text{CONH}(\text{R}^4)$, $-\text{N}(\text{R}^4)\text{COR}$, $-\text{N}(\text{R}^4)\text{CO}_2\text{R}$, $-\text{SO}_2\text{N}(\text{R}^4)_2$,
 $-\text{N}(\text{R}^4)\text{SO}_2\text{R}$, $-\text{N}(\text{R}^6)\text{COCH}_2\text{N}(\text{R}^4)_2$, $-\text{N}(\text{R}^6)\text{COCH}_2\text{CH}_2\text{N}(\text{R}^4)_2$, and
 $-\text{N}(\text{R}^6)\text{COCH}_2\text{CH}_2\text{CH}_2\text{N}(\text{R}^4)_2$, wherein R is selected from
30 hydrogen, C_{1-6} aliphatic, phenyl, a 5-6 membered
heteroaryl ring, or a 5-6 membered heterocyclic ring.
More preferred R^5 substituents include $-\text{Cl}$, $-\text{Br}$, $-\text{F}$, $-\text{CN}$,
 $-\text{CF}_3$, $-\text{COOH}$, $-\text{CONHMe}$, $-\text{CONHEt}$, $-\text{NH}_2$, $-\text{NHAc}$, $-\text{NHSO}_2\text{Me}$,

-NHSO₂Et, -NHSO₂(n-propyl), -NHSO₂(isopropyl), -NHCOEt,
-NHCOCH₂NHCH₃, -NHCOCH₂N(CO₂t-Bu)CH₃, -NHCOCH₂N(CH₃)₂,
-NHCOCH₂CH₂N(CH₃)₂, -NHCOCH₂CH₂CH₂N(CH₃)₂,
-NHCO(cyclopropyl), -NHCO(isobutyl), -NHCOCH₂(morpholin-4-
5 yl), -NHCOCH₂CH₂(morpholin-4-yl), -NHCOCH₂CH₂CH₂(morpholin-
4-yl), -NHCO₂(t-butyl), -NH(C₁₋₄ aliphatic) such as -NHMe,
-N(C₁₋₄ aliphatic)₂ such as -NMe₂, OH, -O(C₁₋₄ aliphatic)
such as -OMe, C₁₋₄ aliphatic such as methyl, ethyl,
cyclopropyl, isopropyl, or t-butyl, and -CO₂(C₁₋₄
10 aliphatic).

Preferred formula IIa compounds have one or more, and more preferably all, of the features selected from the group consisting of:

- (a) R^y is Z-R^{3'} or an optionally substituted group
15 selected from C₁₋₆ aliphatic, 5-6 membered heterocyclyl, phenyl, or 5-6 membered heteroaryl, wherein Z is a methylene and R^{3'} is -N(R⁴)₂, -OR, or an optionally substituted group selected from C₁₋₆ aliphatic, C₆₋₁₀ aryl, a
20 heteroaryl ring having 5-10 ring atoms, or a heterocyclyl ring having 5-10 ring atoms;
- (b) R¹ is T-(Ring D), wherein T is a valence bond or a methylene unit;
- (c) Ring D is a 5-7 membered monocyclic or an 8-10
25 membered bicyclic aryl or heteroaryl ring; and
- (d) R² is -R or -T-W-R⁶ and R^{2'} is hydrogen, or R² and R^{2'} are taken together to form an optionally substituted benzo ring.

More preferred compounds of formula IIa have
30 one or more, and more preferably all, of the features selected from the group consisting of:

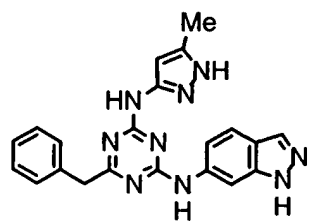
- (a) R^Y is an optionally substituted group selected from C_{1-6} aliphatic, 5-6 membered heterocyclyl, phenyl, or 5-6 membered heteroaryl;
- (b) R^1 is T-(Ring D), wherein T is a valence bond and Q is -S-, -NH-, or -CH₂-;
- (c) Ring D is a 5-6 membered monocyclic or an 8-10 membered bicyclic aryl or heteroaryl ring; and
- (d) R^2 is -R and $R^{2'}$ is hydrogen, wherein R is selected from hydrogen, C_{1-6} aliphatic, phenyl, a 5-6 membered heteroaryl ring, or a 5-6 membered heterocyclic ring.

Even more preferred compounds of formula IIa have one or more, and more preferably all, of the features selected from the group consisting of:

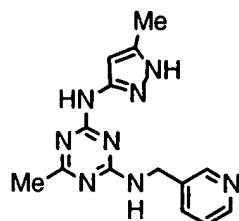
- (a) R^Y is selected from 2-pyridyl, 4-pyridyl, pyrrolidinyl, piperidinyl, morpholinyl, piperazinyl, methyl, ethyl, cyclopropyl, isopropyl, t-butyl, alkoxyalkylamino, alkoxyalkyl, alkyl- or dialkylamino, alkyl- or dialkylaminoalkoxy, acetamido, optionally substituted phenyl, or methoxymethyl;
- (b) R^1 is T-(Ring D), wherein T is a valence bond and Ring D is a 5-6 membered aryl or heteroaryl ring, wherein Ring D is optionally substituted with one to two groups selected from -halo, -CN, -NO₂, -N(R⁴)₂, optionally substituted C_{1-6} aliphatic group, -OR, -CO₂R, -CONH(R⁴), -N(R⁴)COR, -N(R⁴)SO₂R, -N(R⁶)COCH₂CH₂N(R⁴)₂, or -N(R⁶)COCH₂CH₂CH₂N(R⁴)₂, and Q is -S- or -NH-; and
- (c) R^2 is hydrogen or a substituted or unsubstituted C_{1-6} aliphatic, and L is -O-, -S-, or -NH-.

Representative compounds of formula IIa are shown below in Table 1.

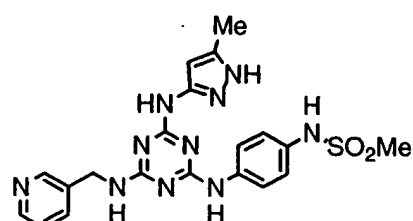
Table 1.



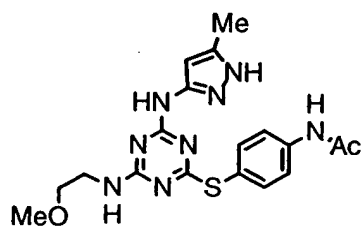
IIa-1



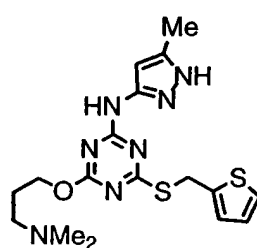
IIa-2



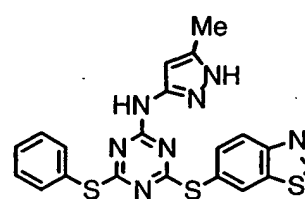
IIa-3



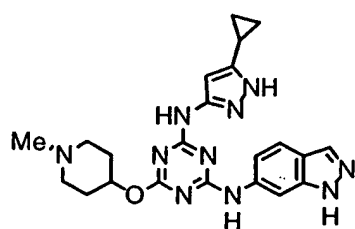
IIa-4



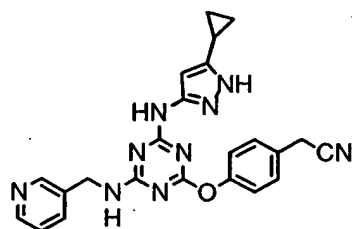
IIa-5



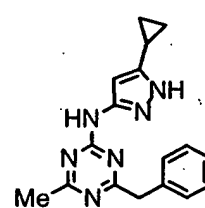
IIa-6



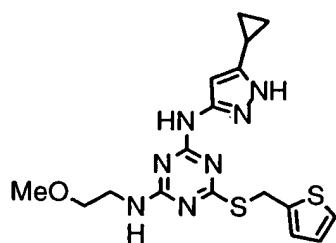
IIa-7



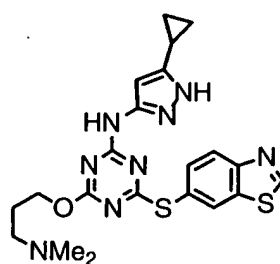
IIa-8



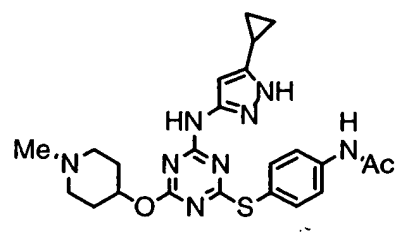
IIa-9



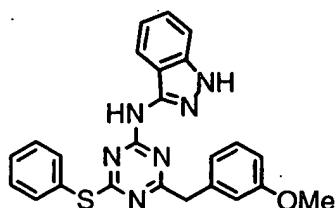
IIa-10



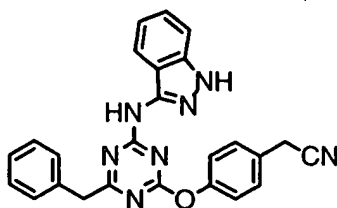
IIa-11



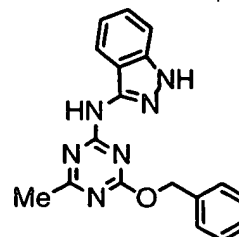
IIa-12



IIa-13



IIa-14



IIa-15

In another embodiment, this invention provides a composition comprising a compound of formula IIa and a pharmaceutically acceptable carrier.

Another aspect of this invention relates to a
5 method of treating or preventing an Aurora-2-mediated disease with an Aurora-2 inhibitor, which method comprises administering to a patient in need of such a treatment a therapeutically effective amount of a compound of formula IIa or a pharmaceutical composition
10 thereof.

Another aspect of this invention relates to a method of inhibiting Aurora-2 activity in a patient, which method comprises administering to the patient a compound of formula IIa or a composition comprising said
15 compound.

Another aspect of this invention relates to a method of treating or preventing a GSK-3-mediated disease with a GSK-3 inhibitor, which method comprises administering to a patient in need of such treatment a
20 therapeutically effective amount of a compound of formula IIa or a pharmaceutical composition thereof.

One aspect of this invention relates to a method of enhancing glycogen synthesis and/or lowering blood levels of glucose in a patient in need thereof,
25 which method comprises administering to the patient a therapeutically effective amount of a compound of formula

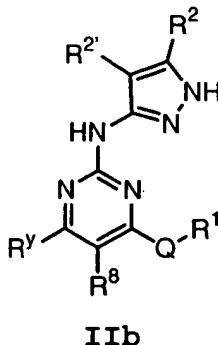
IIa or a pharmaceutical composition thereof. This method is especially useful for diabetic patients. Another method relates to inhibiting the production of hyperphosphorylated Tau protein, which is useful in
5 halting or slowing the progression of Alzheimer's disease. Another method relates to inhibiting the phosphorylation of β -catenin, which is useful for treating schizophrenia.

Another aspect of this invention relates to a
10 method of inhibiting GSK-3 activity in a patient, which method comprises administering to the patient a compound of formula IIa or a composition comprising said compound.

Another method relates to inhibiting Aurora-2 or GSK-3 activity in a biological sample, which method
15 comprises contacting the biological sample with the Aurora-2 or GSK-3 inhibitor of formula IIa, or a pharmaceutical composition thereof, in an amount effective to inhibit Aurora-2 or GSK-3.

Each of the aforementioned methods directed to
20 the inhibition of Aurora-2 or GSK-3, or the treatment of a disease alleviated thereby, is preferably carried out with a preferred compound of formula IIa, as described above.

Another embodiment of this invention relates to
25 compounds of formula IIb:



or a pharmaceutically acceptable derivative or prodrug thereof, wherein:

- R^Y is $Z-R^3$ or an optionally substituted group selected from C_{1-6} aliphatic, C_{6-10} aryl, a heteroaryl ring having
5 5-10 ring atoms, or a heterocyclyl ring having 5-10 ring atoms, or R^Y and R^8 are taken together to form a fused, optionally substituted 5-7 membered, unsaturated or partially unsaturated, ring having 0-3 ring heteroatoms selected from nitrogen, oxygen, or sulfur;
- 10 Q is selected from $-N(R^4)-$, $-O-$, $-S-$, or $-CH(R^6)-$;
 R^1 is T-(Ring D);
Ring D is a 5-7 membered monocyclic ring or 8-10 membered bicyclic ring selected from aryl, heteroaryl, heterocyclyl or carbocyclyl, said heteroaryl or
15 heterocyclyl ring having 1-4 ring heteroatoms selected from nitrogen, oxygen or sulfur, wherein each substitutable ring carbon of Ring D is independently substituted by oxo, $T-R^5$, or $V-Z-R^5$, and each substitutable ring nitrogen of Ring D is independently
20 substituted by $-R^4$;
- T is a valence bond or a C_{1-4} alkylidene chain, wherein when Q is $-CH(R^6)-$, a methylene unit of said C_{1-4} alkylidene chain is optionally replaced by $-O-$, $-S-$, $-N(R^4)-$, $-CO-$, $-CONH-$, $-NHCO-$, $-SO_2-$, $-SO_2NH-$, $-NHSO_2-$,
25 $-CO_2-$, $-OC(O)-$, $-OC(O)NH-$, or $-NHCO_2-$;
- Z is a C_{1-4} alkylidene chain;
- L is $-O-$, $-S-$, $-SO-$, $-SO_2-$, $-N(R^6)SO_2-$, $-SO_2N(R^6)-$, $-N(R^6)-$, $-CO-$, $-CO_2-$, $-N(R^6)CO-$, $-N(R^6)C(O)O-$, $-N(R^6)CON(R^6)-$, $-N(R^6)SO_2N(R^6)-$, $-N(R^6)N(R^6)-$,
30 $-C(O)N(R^6)-$, $-OC(O)N(R^6)-$, $-C(R^6)_2O-$, $-C(R^6)_2S-$, $-C(R^6)_2SO-$, $-C(R^6)_2SO_2-$, $-C(R^6)_2SO_2N(R^6)-$, $-C(R^6)_2N(R^6)-$, $-C(R^6)_2N(R^6)C(O)-$, $-C(R^6)_2N(R^6)C(O)O-$, $-C(R^6)=NN(R^6)-$,

$-C(R^6)=N-O-$, $-C(R^6)_2N(R^6)N(R^6)-$, $-C(R^6)_2N(R^6)SO_2N(R^6)-$, or
 $-C(R^6)_2N(R^6)CON(R^6)-$;

R^2 and $R^{2'}$ are independently selected from $-R$, $-T-W-R^6$, or
 R^2 and $R^{2'}$ are taken together with their intervening
5 atoms to form a fused, 5-8 membered, unsaturated or
partially unsaturated, ring having 0-3 ring heteroatoms
selected from nitrogen, oxygen, or sulfur, wherein each
substitutable ring carbon of said fused ring formed by
 R^2 and $R^{2'}$ is independently substituted by halo, oxo,
10 $-CN$, $-NO_2$, $-R^7$, or $-V-R^6$, and each substitutable ring
nitrogen of said ring formed by R^2 and $R^{2'}$ is
independently substituted by R^4 ;

R^3 is selected from $-halo$, $-OR$, $-C(=O)R$, $-CO_2R$, $-COCOR$,
 $-COCH_2COR$, $-NO_2$, $-CN$, $-S(O)R$, $-S(O)_2R$, $-SR$, $-N(R^4)_2$,
15 $-CON(R^7)_2$, $-SO_2N(R^7)_2$, $-OC(=O)R$, $-N(R^7)COR$, $-N(R^7)CO_2(C_{1-6}$
aliphatic), $-N(R^4)N(R^4)_2$, $-C=NN(R^4)_2$, $-C=N-OR$,
 $-N(R^7)CON(R^7)_2$, $-N(R^7)SO_2N(R^7)_2$, $-N(R^4)SO_2R$,
 $-OC(=O)N(R^7)_2$, or an optionally substituted group
selected from C_{1-6} aliphatic, C_{6-10} aryl, a heteroaryl
20 ring having 5-10 ring atoms, or a heterocyclyl ring
having 5-10 ring atoms;

each R is independently selected from hydrogen or an
optionally substituted group selected from C_{1-6}
aliphatic, C_{6-10} aryl, a heteroaryl ring having 5-10
25 ring atoms, or a heterocyclyl ring having 5-10 ring
atoms;

each R^4 is independently selected from $-R^7$, $-COR^7$,
 $-CO_2$ (optionally substituted C_{1-6} aliphatic), $-CON(R^7)_2$,
or $-SO_2R^7$;

30 each R^5 is independently selected from $-R$, halo, $-OR$,
 $-C(=O)R$, $-CO_2R$, $-COCOR$, $-NO_2$, $-CN$, $-S(O)R$, $-SO_2R$, $-SR$,
 $-N(R^4)_2$, $-CON(R^4)_2$, $-SO_2N(R^4)_2$, $-OC(=O)R$, $-N(R^4)COR$,
 $-N(R^4)CO_2$ (optionally substituted C_{1-6} aliphatic),

$-N(R^4)N(R^4)_2$, $-C=NN(R^4)_2$, $-C=N-OR$, $-N(R^4)CON(R^4)_2$,
 $-N(R^4)SO_2N(R^4)_2$, $-N(R^4)SO_2R$, or $-OC(=O)N(R^4)_2$;

V is $-O-$, $-S-$, $-SO-$, $-SO_2-$, $-N(R^6)SO_2-$, $-SO_2N(R^6)-$,
 $-N(R^6)-$, $-CO-$, $-CO_2-$, $-N(R^6)CO-$, $-N(R^6)C(O)O-$,
5 $-N(R^6)CON(R^6)-$, $-N(R^6)SO_2N(R^6)-$, $-N(R^6)N(R^6)-$,
 $-C(O)N(R^6)-$, $-OC(O)N(R^6)-$, $-C(R^6)_2O-$, $-C(R^6)_2S-$,
 $-C(R^6)_2SO-$, $-C(R^6)_2SO_2-$, $-C(R^6)_2SO_2N(R^6)-$, $-C(R^6)_2N(R^6)-$,
 $-C(R^6)_2N(R^6)C(O)-$, $-C(R^6)_2N(R^6)C(O)O-$, $-C(R^6)=NN(R^6)-$,
 $-C(R^6)=N-O-$, $-C(R^6)_2N(R^6)N(R^6)-$, $-C(R^6)_2N(R^6)SO_2N(R^6)-$, or
10 $-C(R^6)_2N(R^6)CON(R^6)-$;

W is $-C(R^6)_2O-$, $-C(R^6)_2S-$, $-C(R^6)_2SO-$, $-C(R^6)_2SO_2-$,
 $-C(R^6)_2SO_2N(R^6)-$, $-C(R^6)_2N(R^6)-$, $-CO-$, $-CO_2-$,
 $-C(R^6)OC(O)-$, $-C(R^6)OC(O)N(R^6)-$, $-C(R^6)_2N(R^6)CO-$,
 $-C(R^6)_2N(R^6)C(O)O-$, $-C(R^6)=NN(R^6)-$, $-C(R^6)=N-O-$,
15 $-C(R^6)_2N(R^6)N(R^6)-$, $-C(R^6)_2N(R^6)SO_2N(R^6)-$,
 $-C(R^6)_2N(R^6)CON(R^6)-$, or $-CON(R^6)-$;

each R^6 is independently selected from hydrogen or an
optionally substituted C_{1-4} aliphatic group, or two R^6
groups on the same nitrogen atom are taken together
20 with the nitrogen atom to form a 5-6 membered
heterocyclyl or heteroaryl ring;

each R^7 is independently selected from hydrogen or an
optionally substituted C_{1-6} aliphatic group, or two R^7
on the same nitrogen are taken together with the
25 nitrogen to form a 5-8 membered heterocyclyl or
heteroaryl ring; and

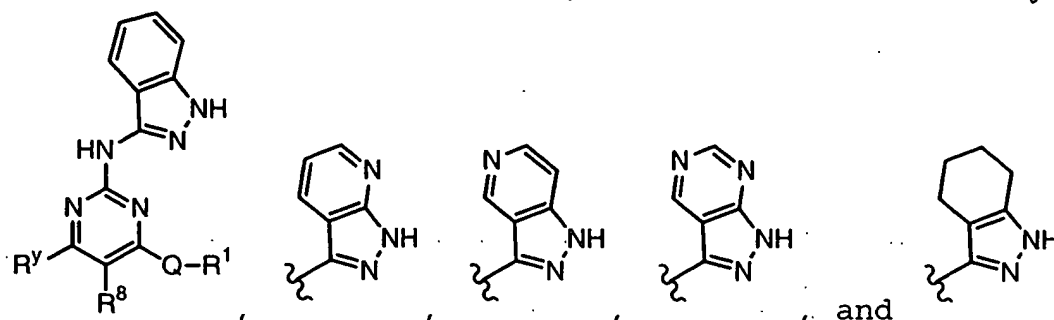
R^8 is selected from $-R$, halo, $-OR$, $-C(=O)R$, $-CO_2R$, $-COCOR$,
 $-NO_2$, $-CN$, $-S(O)R$, $-SO_2R$, $-SR$, $-N(R^4)_2$, $-CON(R^4)_2$,
 $-SO_2N(R^4)_2$, $-OC(=O)R$, $-N(R^4)COR$, $-N(R^4)CO_2$ (optionally
30 substituted C_{1-6} aliphatic), $-N(R^4)N(R^4)_2$, $-C=NN(R^4)_2$,
 $-C=N-OR$, $-N(R^4)CON(R^4)_2$, $-N(R^4)SO_2N(R^4)_2$, $-N(R^4)SO_2R$, or
 $-OC(=O)N(R^4)_2$; provided that when Q is $-NH-$ and R^7 and
 R^8 are taken together to form a fused ring, R^1 is other

than a pyrazol-3-yl ring or a pyrazol-3-yl-containing bicyclic ring system.

Preferred R^Y groups of formula IIb include $Z-R^{3'}$ or an optionally substituted group selected from C_{1-6} aliphatic, 5-6 membered heterocyclyl, phenyl, or 5-6 membered heteroaryl, wherein Z is a methylene and $R^{3'}$ is $-N(R^4)_2$, $-OR$, or an optionally substituted group selected from C_{1-6} aliphatic, C_{6-10} aryl, a heteroaryl ring having 5-10 ring atoms, or a heterocyclyl ring having 5-10 ring atoms..

Examples of preferred R^Y groups include 2-pyridyl, 4-pyridyl, pyrrolidinyl, piperidinyl, morpholinyl, piperazinyl, methyl, ethyl, cyclopropyl, isopropyl, t-butyl, alkoxyalkylamino such as methoxyethylamino, alkoxyalkyl such as methoxymethyl or methoxyethyl, alkyl- or dialkylamino such as ethylamino or dimethylamino, alkyl- or dialkylaminoalkoxy such as dimethylaminopropoxy, acetamido, optionally substituted phenyl such as phenyl or halo-substituted phenyl.

The R^2 and $R^{2'}$ groups of formula IIb may be taken together to form a fused ring, thus providing a bicyclic ring system containing a pyrazole ring. Preferred fused rings include benzo, pyrido, pyrimido, and a partially unsaturated 6-membered carbocyclo ring. These are exemplified in the following formula IIb compounds having a pyrazole-containing bicyclic ring system:



Preferred substituents on the $R^2/R^{2'}$ fused ring of formula IIb include one or more of the following:
 -halo, $-N(R^4)_2$, $-C_{1-4}$ alkyl, $-C_{1-4}$ haloalkyl, $-NO_2$, $-O(C_{1-4}$ alkyl), $-CO_2(C_{1-4}$ alkyl), $-CN$, $-SO_2(C_{1-4}$ alkyl), $-SO_2NH_2$,
 5 $-OC(O)NH_2$, $-NH_2SO_2(C_{1-4}$ alkyl), $-NHC(O)(C_{1-4}$ alkyl), $-C(O)NH_2$, and $-CO(C_{1-4}$ alkyl), wherein the $(C_{1-4}$ alkyl) is a straight, branched, or cyclic alkyl group. Preferably, the $(C_{1-4}$ alkyl) group is methyl.

When the pyrazole ring system of formula IIb is
 10 monocyclic, preferred R^2 groups include hydrogen or a substituted or unsubstituted group selected from aryl, heteroaryl, or a C_{1-6} aliphatic group. Examples of such preferred R^2 groups include H, methyl, ethyl, propyl, , cyclopropyl, i-propyl, cyclopentyl, hydroxypropyl,
 15 methoxypropyl, and benzyloxypropyl. A preferred $R^{2'}$ group is hydrogen.

When Ring D of formula IIb is monocyclic, preferred Ring D groups include phenyl, pyridyl, pyridazinyl, pyrimidinyl, and pyrazinyl.

20 When Ring D of formula IIb is bicyclic, preferred bicyclic Ring D groups include naphthyl, tetrahydronaphthyl, indanyl, benzimidazolyl, quinolinyl, indolyl, isoindolyl, indolinyl, benzo[b]furyl, benzo[b]thiophenyl, indazolyl, benzothiazolyl,
 25 cinnolinyl, phthalazinyl, quinazolinyl, quinoxazolinyl, 1,8-naphthyridinyl and isoquinolinyl.

On Ring D of formula IIb, preferred T-R⁵ or V-Z-R⁵ substituents include -halo, -CN, -NO₂, -N(R⁴)₂, optionally substituted C₁₋₆ aliphatic group, -OR, -C(O)R, -CO₂R, -CONH(R⁴), -N(R⁴)COR, -N(R⁴)CO₂R, -SO₂N(R⁴)₂,
 5 -N(R⁴)SO₂R, -N(R⁶)COCH₂N(R⁴)₂, -N(R⁶)COCH₂CH₂N(R⁴)₂, and -N(R⁶)COCH₂CH₂CH₂N(R⁴)₂, wherein R is selected from hydrogen, C₁₋₆ aliphatic, phenyl, a 5-6 membered heteroaryl ring, or a 5-6 membered heterocyclic ring. More preferred R⁵ substituents include -Cl, -Br, -F, -CN,
 10 -CF₃, -COOH, -CONHMe, -CONHEt, -NH₂, -NHAc, -NHSO₂Me, -NHSO₂Et, -NHSO₂(n-propyl), -NHSO₂(isopropyl), -NHCOEt, -NHCOCH₂NHCH₃, -NHCOCH₂N(CO₂t-Bu)CH₃, -NHCOCH₂N(CH₃)₂, -NHCOCH₂CH₂N(CH₃)₂, -NHCOCH₂CH₂CH₂N(CH₃)₂, -NHCO(cyclopropyl), -NHCO(isobutyl), -NHCOCH₂(morpholin-4-yl),
 15 -NHCOCH₂CH₂(morpholin-4-yl), -NHCOCH₂CH₂CH₂(morpholin-4-yl), -NHCO₂(t-butyl), -NH(C₁₋₄ aliphatic) such as -NHMe, -N(C₁₋₄ aliphatic)₂ such as -NMe₂, OH, -O(C₁₋₄ aliphatic) such as -OMe, C₁₋₄ aliphatic such as methyl, ethyl, cyclopropyl, isopropyl, or t-butyl, and -CO₂(C₁₋₄ aliphatic).
 20 aliphatic).

When R^y and R⁸ are taken together to form a fused ring, preferred rings formed by R^y and R⁸ include 5-6 membered unsaturated or partially unsaturated rings having 0-2 heteroatoms. More preferred fused rings
 25 formed by R^y and R⁸ include benzo, cyclohexo, and pyrido.

Preferred R⁸ groups of formula IIb, when present, include R, OR, and N(R⁴)₂. Examples of preferred R⁸ include methyl, ethyl, NH₂, NH₂CH₂CH₂NH, N(CH₃)₂CH₂CH₂NH, N(CH₃)₂CH₂CH₂O, (piperidin-1-yl)CH₂CH₂O, and NH₂CH₂CH₂O.

30 Preferred formula IIb compounds have one or more, and more preferably all, of the features selected from the group consisting of:

- 5 (a) R^Y is $Z-R^{3'}$ or an optionally substituted group selected from C_{1-6} aliphatic, 5-6 membered heterocyclyl, phenyl, or 5-6 membered heteroaryl, wherein Z is a methylene and $R^{3'}$ is
-N(R^4)₂, -OR, or an optionally substituted group selected from C_{1-6} aliphatic, C_{6-10} aryl, a heteroaryl ring having 5-10 ring atoms, or a heterocyclyl ring having 5-10 ring atoms;
- 10 (b) R^1 is T-(Ring D), wherein T is a valence bond or a methylene unit;
- (c) Ring D is a 5-7 membered monocyclic or an 8-10 membered bicyclic aryl or heteroaryl ring; and
- (d) R^2 is -R or -T-W- R^6 and $R^{2'}$ is hydrogen, or R^2 and $R^{2'}$ are taken together to form an optionally
15 substituted benzo ring.

More preferred compounds of formula IIb have one or more, and more preferably all, of the features selected from the group consisting of:

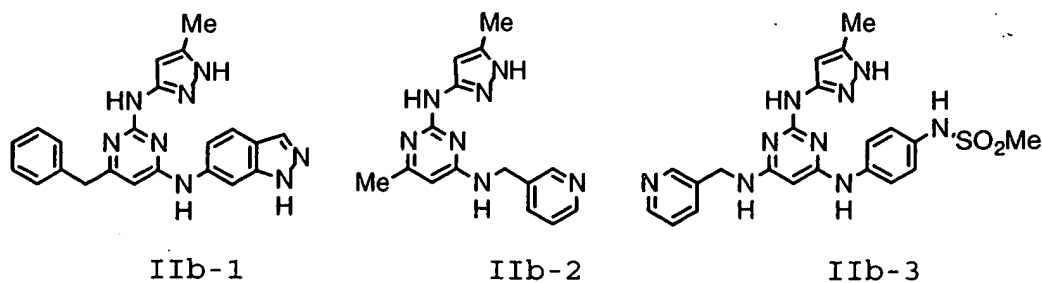
- 20 (a) R^Y is an optionally substituted group selected from C_{1-6} aliphatic, 5-6 membered heterocyclyl, phenyl, or 5-6 membered heteroaryl;
- (b) R^1 is T-(Ring D), wherein T is a valence bond, and Q is -S-, -NH-, or -CH₂-;
- (c) Ring D is a 5-6 membered monocyclic or an 8-10
25 membered bicyclic aryl or heteroaryl ring; and
- (d) R^2 is -R and $R^{2'}$ is hydrogen, wherein R is selected from hydrogen, C_{1-6} aliphatic, phenyl, a 5-6 membered heteroaryl ring, or a 5-6 membered heterocyclic ring.

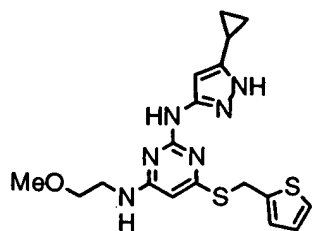
30 Even more preferred compounds of formula IIb have one or more, and more preferably all, of the features selected from the group consisting of:

- (a) R^y is selected from 2-pyridyl, 4-pyridyl, pyrrolidinyl, piperidinyl, morpholinyl, piperazinyl, methyl, ethyl, cyclopropyl, isopropyl, t-butyl, alkoxyalkylamino, alkoxyalkyl, alkyl- or dialkylamino, alkyl- or dialkylaminoalkoxy, acetamido, optionally substituted phenyl, or methoxymethyl, or R^y and R^8 are taken together to form a 5-6 membered unsaturated or partially unsaturated ring having 0-2 heteroatoms selected from nitrogen, oxygen, or sulfur;
- (b) R^1 is T-(Ring D), wherein T is a valence bond and Ring D is a 5-6 membered aryl or heteroaryl ring, wherein Ring D is optionally substituted with one to two groups selected from -halo, -CN, -NO₂, -N(R⁴)₂, optionally substituted C₁₋₆ aliphatic group, -OR, -CO₂R, -CONH(R⁴), -N(R⁴)COR, -N(R⁴)SO₂R, -N(R⁶)COCH₂CH₂N(R⁴)₂, or -N(R⁶)COCH₂CH₂CH₂N(R⁴)₂, and Q is -S- or -NH-; and
- (c) R^2 is hydrogen or a substituted or unsubstituted C₁₋₆ aliphatic, and L is -O-, -S-, or -NH-.

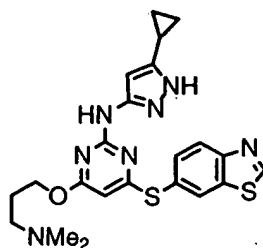
Representative compounds of formula IIb are shown below in Table 2.

Table 2.

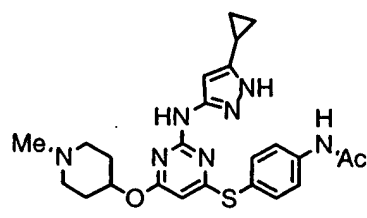




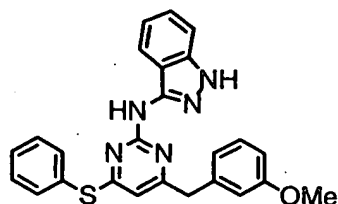
IIb-4



IIb-5



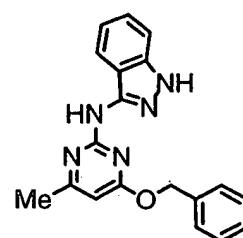
IIb-6



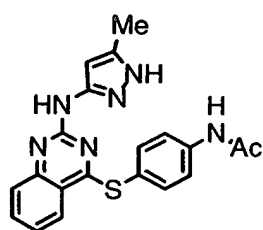
IIb-7



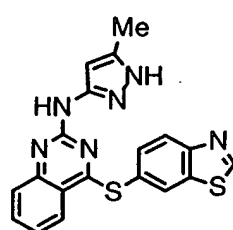
IIb-8



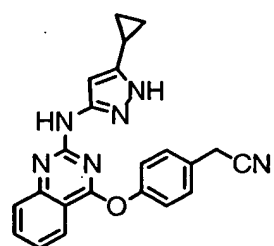
IIb-9



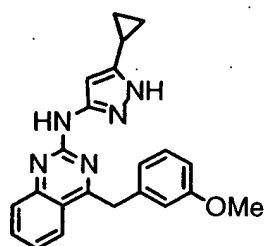
IIb-10



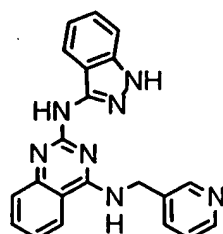
IIb-11



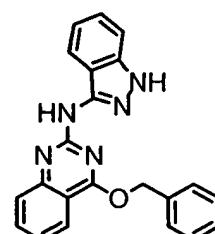
IIb-12



IIb-13



IIb-14



IIb-15

In another embodiment, this invention provides a composition comprising a compound of formula IIb and a pharmaceutically acceptable carrier.

Another aspect of this invention relates to a method of treating or preventing an Aurora-2-mediated

disease with an Aurora-2 inhibitor, which method comprises administering to a patient in need of such a treatment a therapeutically effective amount of a compound of formula IIb or a pharmaceutical composition thereof.

Another aspect of this invention relates to a method of inhibiting Aurora-2 activity in a patient, which method comprises administering to the patient a compound of formula IIb or a composition comprising said compound.

Another aspect of this invention relates to a method of treating or preventing a GSK-3-mediated disease with a GSK-3 inhibitor, which method comprises administering to a patient in need of such a treatment a therapeutically effective amount of a compound of formula IIb or a pharmaceutical composition thereof.

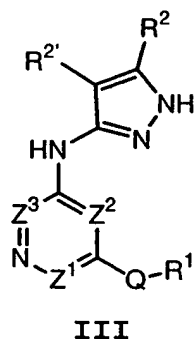
One aspect of this invention relates to a method of enhancing glycogen synthesis and/or lowering blood levels of glucose in a patient in need thereof, which method comprises administering to the patient a therapeutically effective amount of a compound of formula IIb or a pharmaceutical composition thereof. This method is especially useful for diabetic patients. Another method relates to inhibiting the production of hyperphosphorylated Tau protein, which is useful in halting or slowing the progression of Alzheimer's disease. Another method relates to inhibiting the phosphorylation of β -catenin, which is useful for treating schizophrenia.

Another aspect of this invention relates to a method of inhibiting GSK-3 activity in a patient, which method comprises administering to the patient a compound of formula IIb or a composition comprising said compound.

Another method relates to inhibiting Aurora-2 or GSK-3 activity in a biological sample, which method comprises contacting the biological sample with the Aurora-2 or GSK-3 inhibitor of formula IIb, or a pharmaceutical composition thereof, in an amount effective to inhibit Aurora-2 or GSK-3.

Each of the aforementioned methods directed to the inhibition of Aurora-2 or GSK-3, or the treatment of a disease alleviated thereby, is preferably carried out with a preferred compound of formula IIb, as described above.

Another embodiment of this invention relates to compounds of formula III:



or a pharmaceutically acceptable derivative or prodrug thereof, wherein:

Z^1 is nitrogen or CR^8 , Z^2 is nitrogen or CH, and Z^3 is nitrogen or CR^x , provided that one of Z^1 and Z^3 is nitrogen;

R^x is $T-R^3$ or $L-Z-R^3$;

Q is selected from $-N(R^4)-$, $-O-$, $-S-$, or $-CH(R^6)-$;

R^1 is T-(Ring D);

Ring D is a 5-7 membered monocyclic ring or 8-10 membered bicyclic ring selected from aryl, heteroaryl,

heterocyclyl or carbocyclyl, said heteroaryl or

heterocyclyl ring having 1-4 ring heteroatoms selected from nitrogen, oxygen or sulfur, wherein each substitutable ring carbon of Ring D is independently substituted by oxo, T-R⁵, or V-Z-R⁵, and each

5 substitutable ring nitrogen of Ring D is independently substituted by -R⁴;

T is a valence bond or a C₁₋₄ alkylidene chain, wherein when Q is -CH(R⁶)-, a methylene unit of said C₁₋₄ alkylidene chain is optionally replaced by -O-, -S-,

10 -N(R⁴)-, -CO-, -CONH-, -NHCO-, -SO₂-, -SO₂NH-, -NHSO₂-, -CO₂-, -OC(O)-, -OC(O)NH-, or -NHCO₂-;

Z is a C₁₋₄ alkylidene chain;

L is -O-, -S-, -SO-, -SO₂-, -N(R⁶)SO₂-, -SO₂N(R⁶)-, -N(R⁶)-, -CO-, -CO₂-, -N(R⁶)CO-, -N(R⁶)C(O)O-,

15 -N(R⁶)CON(R⁶)-, -N(R⁶)SO₂N(R⁶)-, -N(R⁶)N(R⁶)-, -C(O)N(R⁶)-, -OC(O)N(R⁶)-, -C(R⁶)₂O-, -C(R⁶)₂S-, -C(R⁶)₂SO-, -C(R⁶)₂SO₂-, -C(R⁶)₂SO₂N(R⁶)-, -C(R⁶)₂N(R⁶)-, -C(R⁶)₂N(R⁶)C(O)-, -C(R⁶)₂N(R⁶)C(O)O-, -C(R⁶)=NN(R⁶)-, -C(R⁶)=N-O-, -C(R⁶)₂N(R⁶)N(R⁶)-, -C(R⁶)₂N(R⁶)SO₂N(R⁶)-, or

20 -C(R⁶)₂N(R⁶)CON(R⁶)-;

R² and R^{2'} are independently selected from -R, -T-W-R⁶, or R² and R^{2'} are taken together with their intervening atoms to form a fused, 5-8 membered, unsaturated or partially unsaturated, ring having 0-3 ring heteroatoms

25 selected from nitrogen, oxygen, or sulfur, wherein each substitutable ring carbon of said fused ring formed by R² and R^{2'} is independently substituted by halo, oxo, -CN, -NO₂, -R⁷, or -V-R⁶, and each substitutable ring nitrogen of said ring formed by R² and R^{2'} is

30 independently substituted by R⁴;

R³ is selected from -R, -halo, -OR, -C(=O)R, -CO₂R, -COCOR, -COCH₂COR, -NO₂, -CN, -S(O)R, -S(O)₂R, -SR, -N(R⁴)₂, -CON(R⁷)₂, -SO₂N(R⁷)₂, -OC(=O)R, -N(R⁷)COR,

$-N(R^7)CO_2(C_{1-6} \text{ aliphatic})$, $-N(R^4)N(R^4)_2$, $-C=NN(R^4)_2$,
 $-C=N-OR$, $-N(R^7)CON(R^7)_2$, $-N(R^7)SO_2N(R^7)_2$, $-N(R^4)SO_2R$, or
 $-OC(=O)N(R^7)_2$;

each R is independently selected from hydrogen or an
 5 optionally substituted group selected from C_{1-6}
 aliphatic, C_{6-10} aryl, a heteroaryl ring having 5-10
 ring atoms, or a heterocyclyl ring having 5-10 ring
 atoms;

each R^4 is independently selected from $-R^7$, $-COR^7$,
 10 $-CO_2(\text{optionally substituted } C_{1-6} \text{ aliphatic})$, $-CON(R^7)_2$,
 or $-SO_2R^7$;

each R^5 is independently selected from $-R$, halo, $-OR$,
 $-C(=O)R$, $-CO_2R$, $-COCOR$, $-NO_2$, $-CN$, $-S(O)R$, $-SO_2R$, $-SR$,
 $-N(R^4)_2$, $-CON(R^4)_2$, $-SO_2N(R^4)_2$, $-OC(=O)R$, $-N(R^4)COR$,
 15 $-N(R^4)CO_2(\text{optionally substituted } C_{1-6} \text{ aliphatic})$,
 $-N(R^4)N(R^4)_2$, $-C=NN(R^4)_2$, $-C=N-OR$, $-N(R^4)CON(R^4)_2$,
 $-N(R^4)SO_2N(R^4)_2$, $-N(R^4)SO_2R$, or $-OC(=O)N(R^4)_2$;

V is $-O-$, $-S-$, $-SO-$, $-SO_2-$, $-N(R^6)SO_2-$, $-SO_2N(R^6)-$,
 $-N(R^6)-$, $-CO-$, $-CO_2-$, $-N(R^6)CO-$, $-N(R^6)C(O)O-$,
 20 $-N(R^6)CON(R^6)-$, $-N(R^6)SO_2N(R^6)-$, $-N(R^6)N(R^6)-$,
 $-C(O)N(R^6)-$, $-OC(O)N(R^6)-$, $-C(R^6)_2O-$, $-C(R^6)_2S-$,
 $-C(R^6)_2SO-$, $-C(R^6)_2SO_2-$, $-C(R^6)_2SO_2N(R^6)-$, $-C(R^6)_2N(R^6)-$,
 $-C(R^6)_2N(R^6)C(O)-$, $-C(R^6)_2N(R^6)C(O)O-$, $-C(R^6)=NN(R^6)-$,
 $-C(R^6)=N-O-$, $-C(R^6)_2N(R^6)N(R^6)-$, $-C(R^6)_2N(R^6)SO_2N(R^6)-$, or
 25 $-C(R^6)_2N(R^6)CON(R^6)-$;

W is $-C(R^6)_2O-$, $-C(R^6)_2S-$, $-C(R^6)_2SO-$, $-C(R^6)_2SO_2-$,
 $-C(R^6)_2SO_2N(R^6)-$, $-C(R^6)_2N(R^6)-$, $-CO-$, $-CO_2-$,
 $-C(R^6)OC(O)-$, $-C(R^6)OC(O)N(R^6)-$, $-C(R^6)_2N(R^6)CO-$,
 $-C(R^6)_2N(R^6)C(O)O-$, $-C(R^6)=NN(R^6)-$, $-C(R^6)=N-O-$,
 30 $-C(R^6)_2N(R^6)N(R^6)-$, $-C(R^6)_2N(R^6)SO_2N(R^6)-$,
 $-C(R^6)_2N(R^6)CON(R^6)-$, or $-CON(R^6)-$;

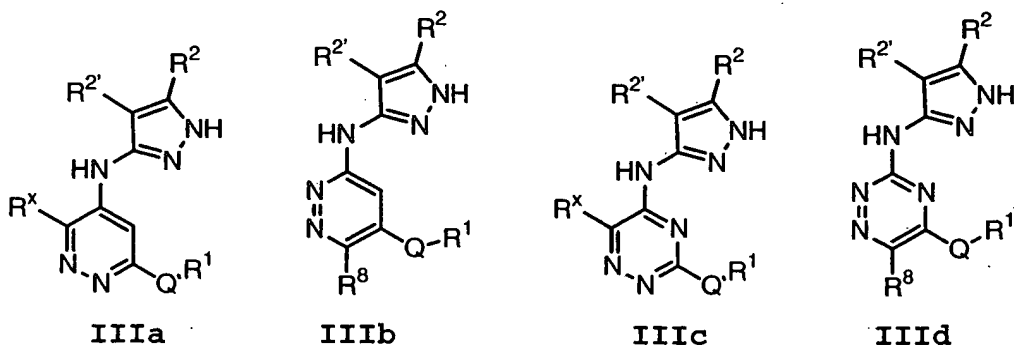
each R^6 is independently selected from hydrogen or an
 optionally substituted C_{1-4} aliphatic group, or two R^6

groups on the same nitrogen atom are taken together with the nitrogen atom to form a 5-6 membered heterocyclyl or heteroaryl ring;

each R⁷ is independently selected from hydrogen or an optionally substituted C₁₋₆ aliphatic group, or two R⁷ on the same nitrogen are taken together with the nitrogen to form a 5-8 membered heterocyclyl or heteroaryl ring; and

R⁸ is selected from -R, halo, -OR, -C(=O)R, -CO₂R, -COCOR, -NO₂, -CN, -S(O)R, -SO₂R, -SR, -N(R⁴)₂, -CON(R⁴)₂, -SO₂N(R⁴)₂, -OC(=O)R, -N(R⁴)COR, -N(R⁴)CO₂(optionally substituted C₁₋₆ aliphatic), -N(R⁴)N(R⁴)₂, -C=NN(R⁴)₂, -C=N-OR, -N(R⁴)CON(R⁴)₂, -N(R⁴)SO₂N(R⁴)₂, -N(R⁴)SO₂R, or -OC(=O)N(R⁴)₂.

Accordingly, the present invention relates to compounds of formula IIIa, IIIb, IIIc and IIId as shown below:

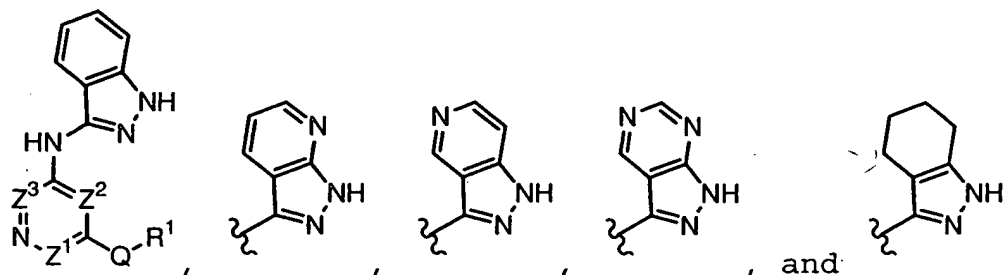


Preferred R^x groups of formula III include T-R³ wherein T is a valence bond or a methylene and R³ is CN, -R, or -OR. When R³ is -R, preferred R³ groups include an optionally substituted group selected from C₁₋₆ aliphatic, phenyl, or a 5-6 membered heteroaryl or heterocyclyl ring. When R³ is -OR, preferred R groups include an optionally substituted group C₁₋₆ aliphatic group such as

alkyl- or dialkylaminoalkyl and aminoalkyl. Examples of preferred R^* include acetamido, CN, piperidiny, piperaziny, phenyl, pyridiny, imidazol-1-yl, imidazol-2-yl, cyclohexyl, cyclopropyl, methyl, ethyl, isopropyl, t-butyl, $NH_2CH_2CH_2NH$, and $NH_2CH_2CH_2O$.

Preferred R^8 groups of formula III, when present, include R, OR, and $N(R^4)_2$. Examples of preferred R^8 include methyl, ethyl, NH_2 , $NH_2CH_2CH_2NH$, $N(CH_3)_2CH_2CH_2NH$, $N(CH_3)_2CH_2CH_2O$, (piperidin-1-yl) CH_2CH_2O , and $NH_2CH_2CH_2O$.

The R^2 and $R^{2'}$ groups of formula III may be taken together to form a fused ring, thus providing a bicyclic ring system containing a pyrazole ring. Preferred fused rings include benzo, pyrido, pyrimido, and a partially unsaturated 6-membered carbocyclo ring. These are exemplified in the following formula III compounds having a pyrazole-containing bicyclic ring system:



Preferred substituents on the formula III $R^2/R^{2'}$ fused ring include one or more of the following: -halo, $-N(R^4)_2$, $-C_{1-4}$ alkyl, $-C_{1-4}$ haloalkyl, $-NO_2$, $-O(C_{1-4}$ alkyl), $-CO_2(C_{1-4}$ alkyl), $-CN$, $-SO_2(C_{1-4}$ alkyl), $-SO_2NH_2$, $-OC(O)NH_2$, $-NH_2SO_2(C_{1-4}$ alkyl), $-NHC(O)(C_{1-4}$ alkyl), $-C(O)NH_2$, and $-CO(C_{1-4}$ alkyl), wherein the $(C_{1-4}$ alkyl) is a straight, branched, or cyclic alkyl group. Preferably, the $(C_{1-4}$ alkyl) group is methyl.

When the pyrazole ring system of formula III is monocyclic, preferred R² groups include hydrogen or a substituted or unsubstituted group selected from aryl, heteroaryl, or a C₁₋₆ aliphatic group. Examples of such preferred R² groups include H, methyl, ethyl, propyl, , cyclopropyl, i-propyl, cyclopentyl, hydroxypropyl, methoxypropyl, and benzyloxypropyl. A preferred R^{2'} group is hydrogen.

When Ring D of formula III is monocyclic, preferred Ring D groups include phenyl, pyridyl, pyridazinyl, pyrimidinyl, and pyrazinyl.

When Ring D of formula III is bicyclic, preferred bicyclic Ring D groups include naphthyl, tetrahydronaphthyl, indanyl, benzimidazolyl, quinolinyl, indolyl, isoindolyl, indolinyl, benzo[b]furyl, benzo[b]thiophenyl, indazolyl, benzothiazolyl, cinnolinyl, phthalazinyl, quinazolinyl, quinoxazolinyl, 1,8-naphthyridinyl and isoquinolinyl.

On Ring D of formula III, preferred T-R⁵ or V-Z-R⁵ substituents include -halo, -CN, -NO₂, -N(R⁴)₂, optionally substituted C₁₋₆ aliphatic group, -OR, -C(O)R, -CO₂R, -CON(R⁴)₂, -OCO(R⁴)₂, -N(R⁴)COR, -N(R⁴)CO₂R, -SO₂N(R⁴)₂, -N(R⁴)SO₂R, -N(R⁶)COCH₂N(R⁴)₂, -N(R⁶)COCH₂CH₂N(R⁴)₂, and -N(R⁶)COCH₂CH₂CH₂N(R⁴)₂, wherein R is selected from hydrogen, C₁₋₆ aliphatic, phenyl, a 5-6 membered heteroaryl ring, or a 5-6 membered heterocyclic ring. More preferred R⁵ substituents include -Cl, -Br, -F, -CN, -CF₃, -COOH, -CONHMe, -CONHEt, -NH₂, -NHAc, -NHCO₂Me, -NHCO₂Et, -NHCO₂(n-propyl), -NHCO₂(isopropyl), -NHCOEt, -NHCOCH₂NHCH₃, -NHCOCH₂N(CO₂t-Bu)CH₃, -NHCOCH₂N(CH₃)₂, -NHCOCH₂CH₂N(CH₃)₂, -NHCOCH₂CH₂CH₂N(CH₃)₂, -NHCO(cyclopropyl), -NHCO(isobutyl), -NHCOCH₂(morpholin-4-yl), -NHCOCH₂CH₂(morpholin-4-yl), -NHCOCH₂CH₂CH₂(morpholin-

4-yl), -NHCO₂(t-butyl), -NH(C₁₋₄ aliphatic) such as -NHMe,
-N(C₁₋₄ aliphatic)₂ such as -NMe₂, OH, -O(C₁₋₄ aliphatic)
such as -OMe, C₁₋₄ aliphatic such as methyl, ethyl,
cyclopropyl, isopropyl, or t-butyl, and -CO₂(C₁₋₄
5 aliphatic).

Preferred compounds of formula IIIa, IIIb,
IIIc, or IIId have one or more, and more preferably all,
of the features selected from the group consisting of:

- (a) R^x is hydrogen, alkyl- or dialkylamino,
10 acetamido, or a C₁₋₄ aliphatic group;
- (b) R¹ is T-(Ring D), wherein T is a valence bond or
a methylene unit;
- (c) Ring D is a 5-7 membered monocyclic or an 8-10
membered bicyclic aryl or heteroaryl ring; and
- 15 (d) R² is -R or -T-W-R⁶ and R^{2'} is hydrogen, or R² and
R^{2'} are taken together to form an optionally
substituted benzo ring.

More preferred compounds of formula IIIa, IIIb,
IIIc, or IIId have one or more, and more preferably all,
20 of the features selected from the group consisting of:

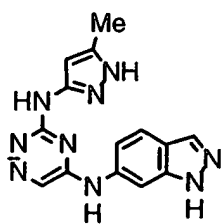
- (a) R¹ is T-(Ring D), wherein T is a valence bond,
and Q is -S-, -NH-, or -CH₂-;
- (b) Ring D is a 5-6 membered monocyclic or an 8-10
membered bicyclic aryl or heteroaryl ring; and
- 25 (c) R² is -R and R^{2'} is hydrogen, wherein R is
selected from hydrogen, C₁₋₆ aliphatic, phenyl, a
5-6 membered heteroaryl ring, or a 5-6 membered
heterocyclic ring.

Even more preferred compounds of formula IIIa,
30 IIIb, IIIc, or IIId have one or more, and more preferably
all, of the features selected from the group consisting
of:

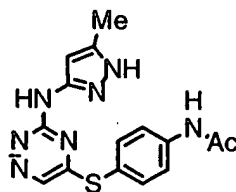
- (a) R^x is hydrogen methyl, ethyl, propyl, cyclopropyl, isopropyl, methylamino or acetimido;
- (b) R^1 is T-(Ring D), wherein T is a valence bond and Ring D is a 5-6 membered aryl or heteroaryl ring, wherein Ring D is optionally substituted with one to two groups selected from -halo, -CN, -NO₂, -N(R⁴)₂, optionally substituted C₁₋₆ aliphatic group, -OR, -CO₂R, -CON(R⁴)₂, -OCO(R⁴)₂, -N(R⁴)COR, -N(R⁴)SO₂R, -N(R⁶)COCH₂CH₂N(R⁴)₂, or -N(R⁶)COCH₂CH₂CH₂N(R⁴)₂, and Q is -S- or -NH-; and
- (c) R^2 is hydrogen or a substituted or unsubstituted C₁₋₆ aliphatic.

Representative compounds of formula III are shown below in Table 3.

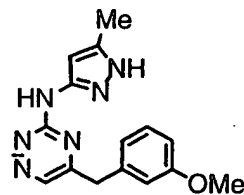
Table 3.



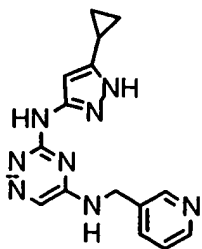
III-1



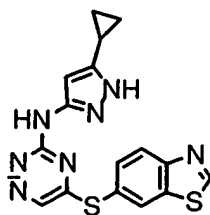
III-2



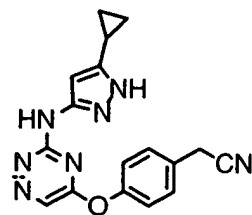
III-3



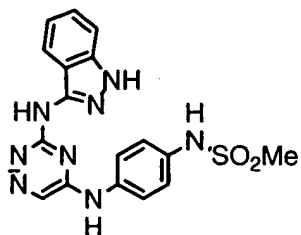
III-4



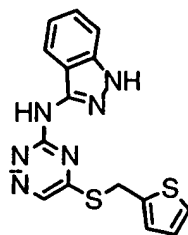
III-5



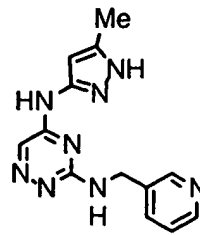
III-6



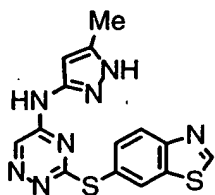
III-7



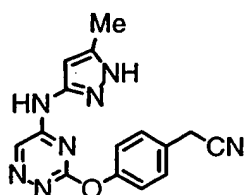
III-8



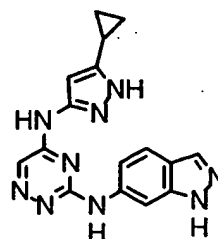
III-9



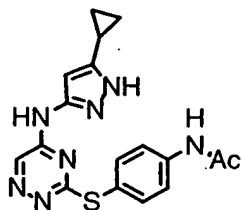
III-10



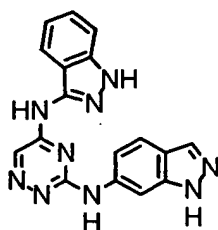
III-11



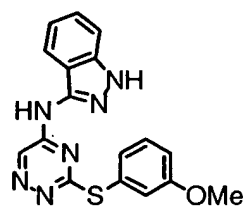
III-12



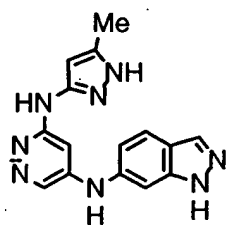
III-13



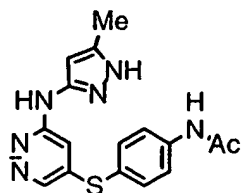
III-14



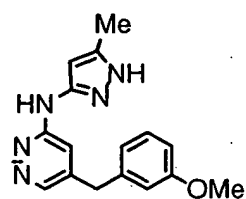
III-15



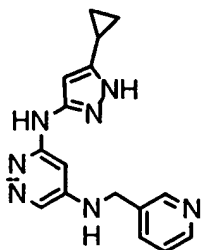
III-16



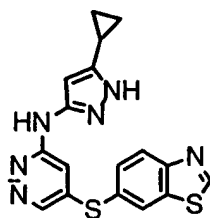
III-17



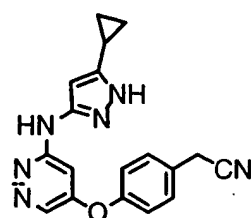
III-18



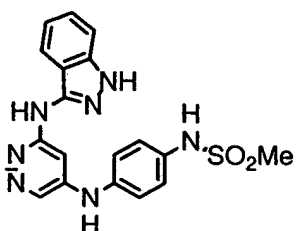
III-19



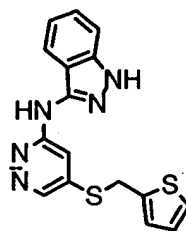
III-20



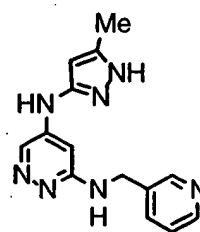
III-21



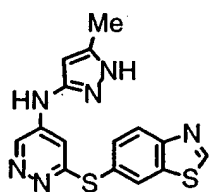
III-22



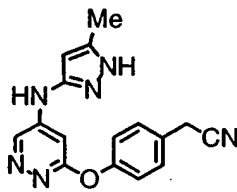
III-23



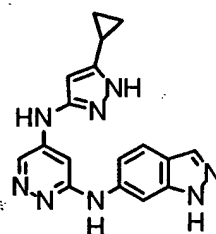
III-24



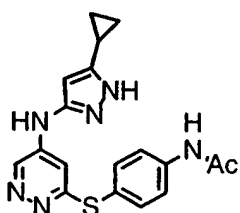
III-25



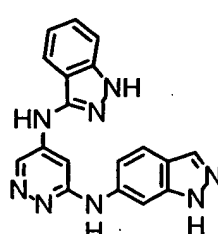
III-26



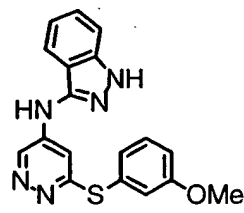
III-27



III-28



III-29



III-30

In another embodiment, this invention provides a composition comprising a compound of formula III and a pharmaceutically acceptable carrier.

Another aspect of this invention relates to a method of treating or preventing an Aurora-2-mediated

disease with an Aurora-2 inhibitor, which method comprises administering to a patient in need of such a treatment a therapeutically effective amount of a compound of formula III or a pharmaceutical composition thereof.

Another aspect of this invention relates to a method of inhibiting Aurora-2 activity in a patient, which method comprises administering to the patient a compound of formula III or a composition comprising said compound.

Another aspect of this invention relates to a method of treating or preventing a GSK-3-mediated disease with a GSK-3 inhibitor, which method comprises administering to a patient in need of such a treatment a therapeutically effective amount of a compound of formula III or a pharmaceutical composition thereof.

One aspect of this invention relates to a method of enhancing glycogen synthesis and/or lowering blood levels of glucose in a patient in need thereof, which method comprises administering to the patient a therapeutically effective amount of a compound of formula III or a pharmaceutical composition thereof. This method is especially useful for diabetic patients. Another method relates to inhibiting the production of hyperphosphorylated Tau protein, which is useful in halting or slowing the progression of Alzheimer's disease. Another method relates to inhibiting the phosphorylation of β -catenin, which is useful for treating schizophrenia.

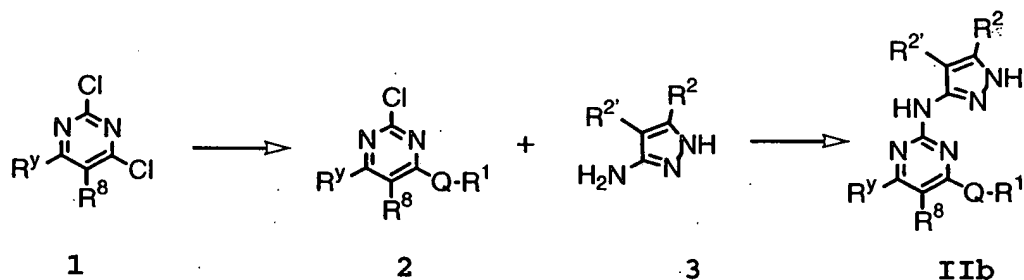
Another aspect of this invention relates to a method of inhibiting GSK-3 activity in a patient, which method comprises administering to the patient a compound of formula III or a composition comprising said compound.

Another method relates to inhibiting Aurora-2 or GSK-3 activity in a biological sample, which method comprises contacting the biological sample with the Aurora-2 or GSK-3 inhibitor of formula III, or a pharmaceutical composition thereof, in an amount effective to inhibit Aurora-2 or GSK-3.

Each of the aforementioned methods directed to the inhibition of Aurora-2 or GSK-3, or the treatment of a disease alleviated thereby, is preferably carried out with a preferred compound of formula III as described above.

The compounds of this invention may be prepared in general by methods known to those skilled in the art for analogous compounds, as illustrated by the general Schemes I-VII.

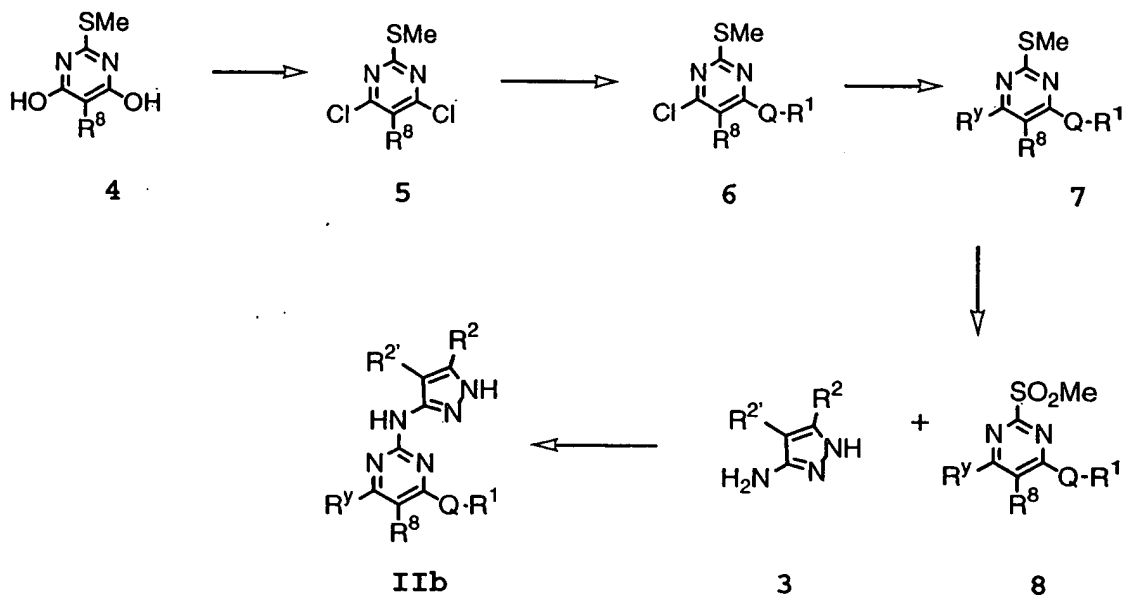
Scheme I



Scheme I above shows a general route for the preparation of compounds of formula IIb. The dichloro intermediate 1 (prepared using methods similar to those reported in *J. Indian. Chem. Soc.*, 61, 690-693 (1984) or in *J. Med. Chem.*, 37, 3828-3833 (1994)) is sequentially reacted with two nucleophiles: R¹-QH to displace the chloride at position 4 to afford intermediate 2; and then 2 is treated with an aminopyrazole (or aminoindazole) to displace the chloride at position 2, using procedures

similar to those described in *J. Med. Chem.*, **38**, 14, 2763-2773, (1995) to afford compounds of formula **IIb**.

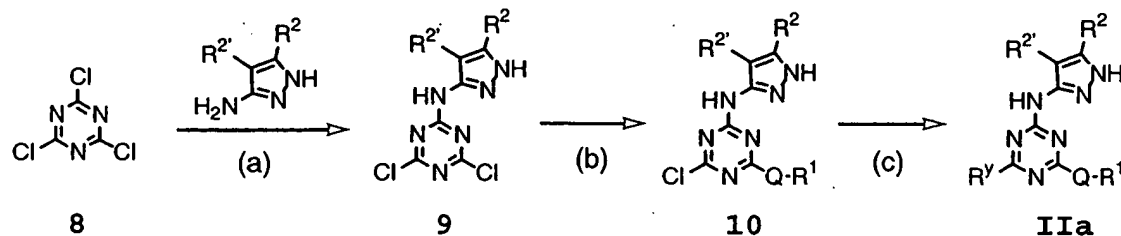
Scheme II



Scheme II above shows a general route for the preparation of compounds of formula **IIb** wherein Q is an N, O or S linker and R^y is a group attached to the pyrimidine core via a heteroatom. Starting material 4,6-dihydroxy-2-methylsulfanylpurine (**4**) is prepared using procedures similar to those reported in *J. Med. Chem.*, **27**, 12, 1621-1629 (1984). Chlorination of **4** with POCl₃ affords the dichloro intermediate **5**. The two chlorides of **5** are sequentially displaced with the appropriate R¹-QH, to afford compound **6**, and then with R^y-H (amine, alcohol, or thiol) to afford compound **7** using procedures similar to those reported in US Patent 2,585,906. Alternatively, the order of displacement may be reversed by first displacing with R^y-H and then with R¹-QH. The methyl sulfanyl group of compound **7** is then oxidized (for example, with oxone) to afford compound **8** and the resulting methylsulfonyl is finally displaced with the amino moiety of aminopyrazole (or aminoindazole)

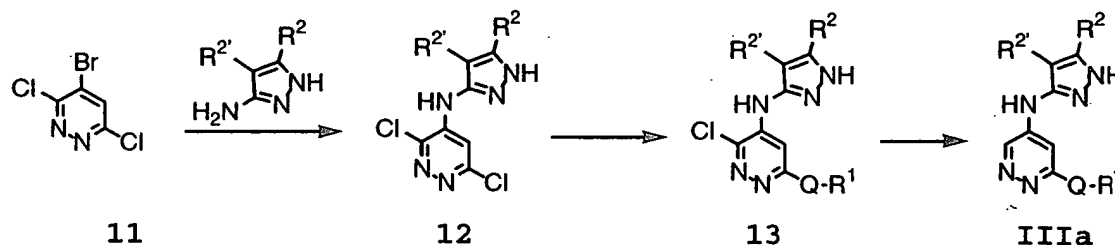
by methods substantially similar to those described above for Scheme 1 step (b) to afford compounds of formula IIb.

Scheme III



Scheme III above shows a general route for the preparation of compounds of formula IIa. The three chlorides of starting material **8** are sequentially displaced with (a) the amino moiety of aminopyrazole (or aminoindazole) to afford compound **9**, (b) the R¹-QH group to afford compound **10**, and (c) R^Y-H (amine, alcohol, or thiol) using procedures similar to the ones reported in *J. Indian Chem. Soc.*, 53, 207-208, (1976) to afford compounds of formula IIa. These three steps can also be performed in different order to afford compounds of formula IIa.

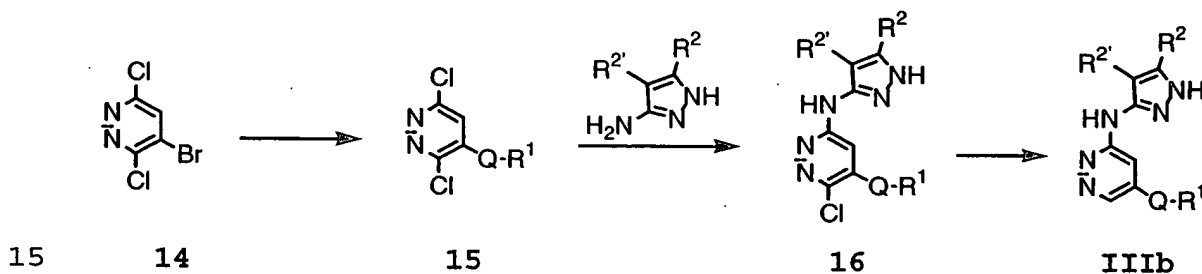
Scheme IV



Scheme IV above shows a general route for the preparation of compounds of formula IIIa. Treatment of **11** with aminopyrazole (or aminoindazole) to provide **12** may be performed in a manner similar to that described in

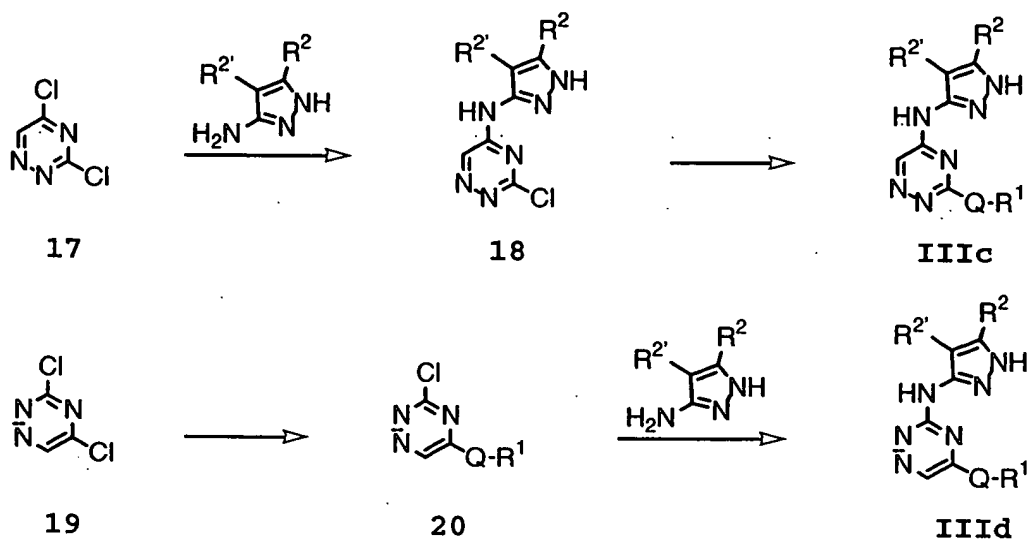
Heterocycles, 51, 5, 1999, 1035-1050. The intermediate 13 is obtained by displacement with R^1 -QH in a manner similar to that described in *Farmaco. Ed. Sci.*, 27, 1972, 591-600. For the preparation of compounds of formula 5 **IIIa** where R^x is hydrogen, the chlorine may be removed by reduction. Alternatively, for the preparation of compounds of formula **IIIa** where R^x is other than hydrogen, the chlorine may be displaced by methods known to those skilled in the art to afford compounds with a variety of 10 R^x substituents.

Scheme V



Scheme V above shows a general route for the preparation of the compounds of formula **IIIb**. Displacement of the bromide with R^1 -QH to afford compound 20 **15** may be performed in a manner similar to that described in *Heterocycles*, 51, 5, 1999, 1035-1050. Displacement of the chlorines may be carried out sequentially as described above.

Scheme VI



Scheme VI above shows a general route for the preparation of the compounds of formulae IIIc and IIId. The displacement with aminopyrazole (or aminoindazole) followed by the displacement with R¹-QH may be performed in a manner similar to that described in *Indian J. Chem. Sect. B*, 29, 5, 1990, 435-439.

In order that the invention described herein may be more fully understood, the following examples are set forth. It should be understood that these examples are for illustrative purposes only and are not to be construed as limiting this invention in any manner.

BIOLOGICAL TESTING

The activity of the compounds as protein kinase inhibitors may be assayed *in vitro*, *in vivo* or in a cell line. *In vitro* assays include assays that determine inhibition of either the phosphorylation activity or ATPase activity of the activated protein kinase. Alternate *in vitro* assays quantitate the ability of the inhibitor to bind to the protein kinase. Inhibitor

binding may be measured by radiolabelling the inhibitor prior to binding, isolating the inhibitor/protein kinase complex and determining the amount of radiolabel bound. Alternatively, inhibitor binding may be determined by running a competition experiment where new inhibitors are incubated with the protein kinase bound to known radioligands.

BIOLOGICAL TESTING EXAMPLE 1

10 K_i DETERMINATION FOR THE INHIBITION OF GSK-3

Compounds are screened for their ability to inhibit GSK-3 β (AA 1-420) activity using a standard coupled enzyme system (Fox et al. (1998) *Protein Sci.* 7, 2249). Reactions are carried out in a solution containing 100 mM HEPES (pH 7.5), 10 mM MgCl₂, 25 mM NaCl, 300 μ M NADH, 1 mM DTT and 1.5% DMSO. Final substrate concentrations in the assay are 20 μ M ATP (Sigma Chemicals, St Louis, MO) and 300 μ M peptide (HSSPHQS(PO₃H₂)EDEEE, American Peptide, Sunnyvale, CA). Reactions are carried out at 30 °C and 20 nM GSK-3 β . Final concentrations of the components of the coupled enzyme system are 2.5 mM phosphoenolpyruvate, 300 μ M NADH, 30 μ g/ml pyruvate kinase and 10 μ g/ml lactate dehydrogenase.

25 An assay stock buffer solution is prepared containing all of the reagents listed above with the exception of ATP and the test compound of interest. The assay stock buffer solution (175 μ l) is incubated in a 96 well plate with 5 μ l of the test compound of interest at final concentrations spanning 0.002 μ M to 30 μ M at 30 °C for 10 min. Typically, a 12 point titration is conducted by preparing serial dilutions (from 10 mM compound

stocks) with DMSO of the test compounds in daughter plates. The reaction is initiated by the addition of 20 μ l of ATP (final concentration 20 μ M). Rates of reaction are obtained using a Molecular Devices Spectramax plate reader (Sunnyvale, CA) over 10 min at 30°C. The K_i values are determined from the rate data as a function of inhibitor concentration.

BIOLOGICAL TESTING EXAMPLE 2

10 K_i DETERMINATION FOR THE INHIBITION OF AURORA-2

Compounds are screened in the following manner for their ability to inhibit Aurora-2 using a standard coupled enzyme assay (Fox et al (1998) *Protein Sci* 7, 2249).

15 To an assay stock buffer solution containing 0.1M HEPES 7.5, 10 mM $MgCl_2$, 1 mM DTT, 25 mM NaCl, 2.5 mM phosphoenolpyruvate, 300 mM NADH, 30 mg/ml pyruvate kinase, 10 mg/ml lactate dehydrogenase, 40 mM ATP, and 800 μ M peptide (LRRASLG, American Peptide, Sunnyvale, CA)
20 is added a DMSO solution of a compound of the present invention to a final concentration of 30 μ M. The resulting mixture is incubated at 30 °C for 10 min. The reaction is initiated by the addition of 10 μ L of Aurora-2 stock solution to give a final concentration of 70 nM
25 in the assay. The rates of reaction are obtained by monitoring absorbance at 340 nm over a 5 minute read time at 30 °C using a BioRad Ultramark plate reader (Hercules, CA). The K_i values are determined from the rate data as a function of inhibitor concentration.

30 While we have presented a number of embodiments of this invention, it is apparent that our basic construction can be altered to provide other embodiments which utilize the compounds and methods of this

invention. Therefore, it will be appreciated that the scope of this invention is to be defined by the appended claims rather than by the specific embodiments which have been represented by way of example.